The Livestock Sub-sector in Kenya's NDC: a scoping of gaps and priorities

GLOBAL RESEARCH ALLIANCE ON AGRICULTURAL GREENHOUSE GASES

CGIAR

RESEARCH PROGRAM ON Climate Change, Agriculture and Food Security

CCAFS

UNIQUE forestry and land use

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ASALs	Arid and Semi-Arid Areas
ASGTS	Agriculture Sector Growth and Transformation Strategy
BAU	Business As Usual
CCAFS	Climate Change Agriculture and Food Security program of the CGIAR
CSA	climate smart agriculture
GHG	greenhouse gas
GRA	Global Research Alliance
IFAD	International Fund for Agricultural Development
KALRO	Kenya Agriculture and livestock research organization
KCSAIF	Kenya Climate Smart Agriculture Strategy and Implementation Framework
MRV	measurement, reporting and verification
NAIP	National Agriculture Investment Plan
NAP	National Adaptation Plan
NCCAP	National Climate Change Action Plan
NDC	Nationally Determined Contribution
NAMA	National Adaptation and Mitigation Action
NARIGP	National Agricultural and Rural Inclusive Growth Project
SNC	Second National Communication
UNFCCC	United Nations Framework Convention on Climate Change

SUMMARY

Under the Paris Agreement, countries should update their Nationally Determined Contribution (NDC) every five years, with progressive ambition in each new submission. Kenya plans to review and revise its NDC in June 2020. The State Department for Livestock has undertaken a stock-taking exercise with support from UNIQUE forestry and land use, CCAFS and GRA. This report summarizes the main findings and recommendations for the livestock sub-sector contribution to enhanced climate change ambition.

The livestock sub-sector is well aligned with Kenya's comprehensive policy framework: The livestock sub-sector is critical to achieving Kenya's development objectives, including the Big Four Agenda and the Agriculture Sector Growth and Transformation Strategy (ASGTS, 2019-2029). The prioritization exercise that informed the ASGTS highlighted dairy, beef, sheep/goat, poultry and camel as being among Kenya's 13 value chains with high potential for agricultural transformation and are central to achieving the objectives of the three ASGTS anchors.

The Kenya Climate Smart Agriculture Strategy and Implementation Framework (KCSAIF) sets out clear actions that are in line with livestock sub-sector priorities. With the exception of the dairy industry where some progress has been made, implementation of the KCSAIF in different livestock industries (e.g. beef, sheep, goats, poultry) is in its early stages.

The livestock sub-sector is central to Kenya's climate change ambitions: Livestock is the largest source of GHG emissions in the agricultural sector, accounting for over 50% of GHG emissions in the Second National Communication, mainly due to enteric fermentation. Trends in livestock GHG emissions are also key drivers of the business as usual (BAU) scenario in Kenya's first NDC. The projections underlying the BAU scenario in the first NDC assumed 1% annual average growth in enteric fermentation emissions from 2010 to 2030. Official livestock population data combined with IPCC 2006 Tier 1 emission factors show that from 2000 to 2018 enteric fermentation emissions in fact increased by 8.5% per year, and have exceeded the BAU projections in every year since 2007. Assuming annual growth of 3.34%, livestock enteric fermentation emissions in 2030 could exceed 33 Mt CO_2e, which is more than double the estimated emissions in 2010. Increasing livestock GHG emissions are mainly driven by rising demand for meat and milk due to increasing population, urbanization and rising incomes. As other sectors decarbonize, agricultural emissions – led by livestock emissions – will become more important.

Livestock can also contribute to GHG mitigation. A Dairy NAMA has been proposed, with an estimated mitigation potential of 8.8 Mt CO_2e over a 10-year period. The Dairy NAMA has not yet been implemented due to lack of financial support. Other livestock industries also have mitigation potential and there are strong synergies with adaptation. However, the technical feasibility, costs and benefits have not yet been assessed in detail. The majority of non-dairy cattle and small ruminants are raised in the arid and semi-arid areas, where adaptation to climate change and food security are national priorities.

Livestock sub-sector contributions to enhanced NDC: NDCs can be enhanced on the basis of a stocking taking of trends, policies and measures, and actions of sub-national and non-state actors in the sector; by updating assumptions and analysis; by ensuring alignment of the NDC with sector development objectives; by ensuring complete coverage of sectors and sub-sectors; and

by ensuring that adaptation priorities, policies and plans are appropriately reflected. Based on a stock-taking, the following pathways to NDC enhancement have been identified in the livestock sector.

In addition to pursuing financing of the Dairy NAMA, in line with the recommendation in the Mitigation Technical Analysis Report, during the 2018-2022 National Climate Change Action Plan implementation period the livestock sub-sector should build expertise and improve data for mitigation action, while focusing climate change efforts on adaptation. In particular, actions to enhance mitigation ambition and promote adaptation actions are proposed in the following four areas.

(1) In-depth assessment and identification of adaptation and mitigation options. *This will contribute to identification of feasible livestock sub-sector climate actions for inclusion in the third NDC.*

- Documentation of vulnerability to climate change and extreme events by livestock in different production systems and in grasslands, for evidenced based development of policies and measures in the livestock sub-sector.
- In-depth feasibility assessment in each production system for each livestock species for upscaled implementation of key adaptation and mitigation strategies.
- Inventory of domestic (national and county government, non-government, private sector) and internationally-supported initiatives that promote key adaptation and mitigation strategies.
- Stakeholder-led identification of adaptation and mitigation initiatives for upscaling.

(2) Develop a Livestock Sub-Sector Climate Change Action Plan. *This will support coordination in the sub-sector and assist in resource mobilization for enhanced climate action.*

- Engage stakeholders and key supporting institutions in the main initiatives in each production system for each species to identify actions to support upscaled implementation of key adaptation and mitigation actions in the livestock sub-sector and ensure coordination with stakeholders.
- Develop strategies for the national government to promote climate smart agriculture (CSA) in the livestock sub-sector, including:
  - strategies to ensure that these actions are mainstreamed in the workplans of state department for livestock divisions and units and related semi-autonomous government agencies;
  - strategies to ensure that these actions are mainstreamed in the work of other relevant MDAs and county governments;
  - strategies to support non-government and private sector actors to address sector support needs;
  - coordination mechanisms to engage the key stakeholders in each strategy.

(3) Improve monitoring and evaluation of livestock sub-sector climate actions. *This will support sector coordination, enable tracking of non-state climate actions and support UNFCCC reporting*

- Design livestock CSA monitoring & evaluation (M&E) system to provide and track information on:
  - Progress in implementing Livestock Sub-sector Climate Change Action Plan;
  - KCSAIF M&E framework indicators;

        - Information required by sub-sector stakeholders;
    - Other indicators as required by national measurement, reporting and verification (MRV) systems (e.g. adaptation and mitigation action registry).

(4) Improve MRV of livestock GHG emissions. *This will improve national capacities for MRV to support implementation and tracking of climate actions.*

- GHG inventory compilation:
    - Continue to compile and submit the Tier 2 dairy cattle GHG inventory on an annual basis;
    - Expand application of Tier 2 method to the other livestock species;
    - Continue to build state department for livestock capacity for GHG inventory compilation.
- GHG inventory improvement:
    - Collaborate with national and county stakeholders to improve livestock administrative statistics in line with GHG inventory data needs;
    - Strengthen county capacities for improved livestock data collection.
- MRV system improvement:
    - Revise NDC GHG BAU projections for livestock GHG emissions based on Tier 2 emission factors and revised livestock population time series in view of the 2019 livestock census results;
    - Develop models for tracking change in emission intensity of livestock production in line with key adaptation and mitigation strategies.

This report summarizes the state of knowledge and action in the livestock sub-sector regarding adaptation and mitigation, highlighting gaps and priorities for future policy developments. The first chapter provides a general overview of the sector's position in relation to climate change in Kenya. The following four chapters review priorities for adaptation and mitigation for each of the main livestock species (dairy cattle, non-dairy cattle, small ruminants and poultry). The final chapter assesses policy and institutional issues, and provides recommendations for the State Department for Livestock, with a focus on near-term actions to increase the livestock sector's support to enhanced climate change ambitions.

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1 CONTEXT FOR THE STOCK-TAKING

In 2020, signatories to the Paris Agreement are updating their Nationally Determined Contribution (NDC). Many countries' NDCs include both mitigation and adaptation, and adaptation is often prioritized in the agriculture sector. One way to update agriculture's contribution to an NDC is to identify existing policies and measures, prioritize adaptation policies and measures, and estimate the impacts of implementing these measures on GHG emissions. Unconditional targets can be set for policies and measures for which domestic support has already been obtained, and conditional targets for policies and measures requiring international support.

This assessment of options for updating the contribution of the livestock sector to Kenya's NDC found that this approach to NDC updating would not result in confident estimates of the effects of policies and measures. This is due to significant gaps in information on the status of policy implementation and gaps in knowledge of the adaptation and mitigation effects of policies and measures. Identifying these gaps and options to address them sets out a pathway for Kenya's State Department for Livestock and sector stakeholders to work towards updating Kenya's Third NDC (2025) on the basis of in-depth assessment and consultation. Updating the Third NDC on this basis would ensure that any commitments are based on robust evidence and have broad support among stakeholders.

1.1 Policy context

Kenya's vulnerability to the impacts of climate change is exacerbated by the high dependence on climate sensitive natural resources. In response, Kenya developed a National Climate Change Response Strategy (NCCRS 2010) which was followed by the National Climate Change Action Plan (NCCAP 2013-17, now updated for the period 2018-22) and the National Adaptation Plan (NAP, 2015-2030). Kenya signed the Paris Agreement in 2016 and submitted its first Nationally Determined Contribution (NDC). Kenya's first NDC includes both mitigation and adaptation components. Kenya's NDC adaptation priorities are aligned with the NCCAP and National Adaptation Plan. For mitigation, Kenya's first NDC states the aim to achieve a low carbon, climate resilient development pathway, and will continue to implement the NCCAP (2018-2022) and subsequent action plans beyond this period to achieve this target. In the agriculture sector, this will include the promotion of climate smart agriculture (CSA) practices and implementation of the Kenya Climate Smart Agriculture Implementation Framework (KCSAIF). KCSAIF prioritizes moving towards a climate-resilient agriculture sector and "taking actions where possible to encourage greenhouse gas (GHG) emissions that are lower than business-as-usual practice". So, while livestock account for over 50% of GHG emissions in the agriculture sector, adaptation remains the top priority.

KCSAIF sets out actions that are in line with livestock sub-sector priorities. Many listed actions are generic and more work is required to see how they can be operationalized in the livestock sub-sector. With the exception of the dairy industry where some progress has been made, implementation of the KCSAIF in different livestock industries (e.g. beef, sheep/goats, poultry) is in its early stages.

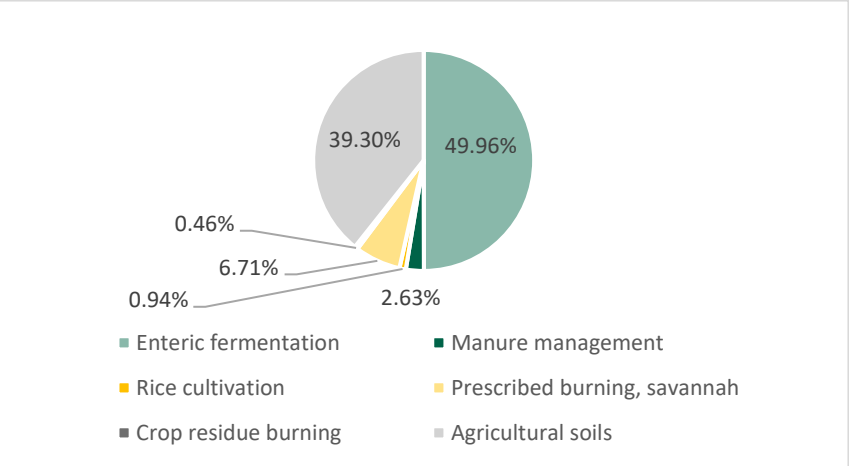
The livestock sub-sector is critical to achieving Kenya's agricultural development objectives, including the Big Four Agenda and the Agriculture Sector Growth and Transformation Strategy

(ASGTS, 2019-2029). The prioritization exercise that informed the ASGTS highlighted dairy, beef, sheep/goat, poultry and camel as being among Kenya's 13 value chains with high potential for agricultural transformation and these value chains are central to achieving the objectives of the three ASGTS anchors.

1.2 Climate change mitigation and adaptation

Livestock is the largest source of GHG emissions in the agricultural sector. The Second National Communication (SNC, 2015) estimated that of the agricultural sector's 29.6 Mt CO_2e emissions in 2010, more than 50% were enteric fermentation and manure management emissions from livestock. Further livestock emissions are included in the 'agricultural soils' category (Figure 1).

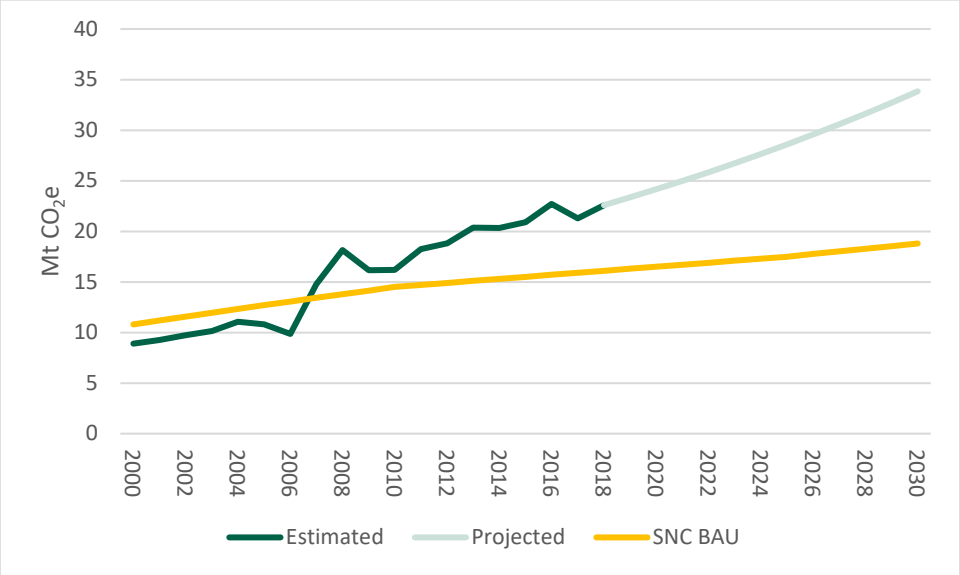
Figure 1: Kenya agricultural GHG emissions, 2010



Source: SNC (2015)

Trends in livestock GHG emissions are also key drivers of the business-as-usual (BAU) scenario in Kenya's first NDC. The data presented in the SNC showed 3.34% annual average growth in enteric fermentation emissions from 2000 to 2010, and the BAU scenario assumed 1% annual average growth from 2010 to 2030. The SNC was based on official livestock population data that was subsequently revised in light of the 2009 livestock census results. The revised livestock population data combined with IPCC 2006 Tier 1 emission factors show that from 2000 to 2018 enteric fermentation emissions in fact increased by 8.5% per year, and have exceeded the BAU projections in every year since 2007 (Figure 2). Assuming growth of 3.34% (which is slightly below the 3.6% human population growth rate projected by the UN), livestock enteric fermentation emissions in 2030 could exceed 33 Mt CO_2e, which is more than double the estimated emissions in 2010. Rapid increase in livestock GHG emissions is mainly driven by the rising demand for meat and milk due to increasing population, urbanization and rising incomes. As other sectors decarbonize, agricultural emissions – led by livestock emissions – will become more important.

Figure 2: Enteric fermentation emissions in the First NDC BAU scenario, re-estimated emissions 2000-2018 and projected emissions 2018-2030



Note: SNC BAU reconstructed from data in MTAR Table 3.1. Estimated emissions use State Department for Livestock data for cattle populations and FAO data for other livestock populations with IPCC (2006) Tier 1 emission factors. Projection assumes 3.34% annual growth rate.

Livestock can also contribute to GHG mitigation. A Dairy NAMA has been proposed, with an estimated mitigation potential of 8.8 Mt CO_2e over a 10-year period. The Dairy NAMA is designed to target about 15% of dairy cattle in Kenya, and with successful initial implementation, could be further upscaled. The Dairy NAMA has not yet been implemented due to lack of financial support. As the following chapters show, other livestock industries also have mitigation potential and there are strong synergies with adaptation. However, for most options the technical feasibility, costs and benefits have not yet been assessed in detail, and for most livestock industries, climate risks and adaptation options have not been systematically assessed.

2 DAIRY CATTLE SUB-SECTOR

2.1 Overview

The dairy sub-sector is the sixth largest sub-sector by marketed value in Kenya's agriculture sector (NAIP 2019). The dairy cattle population has been estimated at about 5.1 million cattle in 2018, accounting for about 25% of Kenya's total cattle population (SDL 2018). About 90% of dairy cattle are concentrated in 21 counties, mostly in the Rift Valley and central regions of the country, with pockets of major production in western and eastern areas. The vast majority of dairy cattle are raised on smallholder farms, but farms with larger herds and commercial farms are also common in some areas. About half of dairy cattle are raised in semi-intensive areas, where semi-zero grazing is the most common feeding system. About 28% are in zero grazing systems, and 20% in full grazing systems (SDL 2020).

Dairy cattle milk production was estimated at about 3.8 billion liters in 2018. Of this, about 16% is delivered to dairy processors in the formal sector, but most is consumed on-farm or sold to the informal market. Farmer cooperatives handle about 18.7 million liters of milk worth about KES 5.6 billion (KNBS 2020). Informal market sales are particularly important for rural women's incomes, because they are less able to control incomes from formal market sales (Tavenner & Crane, 2018; Wilkes et al. 2020a). Overall, the dairy sector makes key contributions to farmers' incomes, food security and nutrition (both through on-farm consumption and income from milk sales) and employment, generating about 13 jobs for every 1,000 litres of milk handled in processing, and 18 jobs per 1,000 liters handled in the informal sector (Muriuki, 2011).

Table 1. Cattle population, milk production and marketing 2012-2018

Year	Dairy Cattle (head)	Milk production (liters)	Of which	
			Formally marketed	Consumed or informally marketed
2012	4,340,278	3,906,250,200	-	-
2013	4,505,582	4,055,023,800	-	-
2014	4,316,153	3,884,537,700	-	-
2015	4,242,132	3,817,918,800	16.1%	83.9%
2016	4,505,733	4,055,159,700	16.0%	84.0%
2017	4,573,871	3,560,701,586	15.0%	85.0%
2018	5,135,875	3,778,206,805	16.8%	83.2%

Note: Population and milk production data from SDL (2018), marketed milk from KNBS (2020).

Average milk yields on smallholder farms are low, but have been gradually increasing over time. One estimate suggests that average annual milk yields per cow have increased from about 1880 kg in 1994 to 2000 kg in 2017, and annual average increase of about 0.3% per year, mainly because of an increase in the proportion of specialized dairy breeds, such as Holstein-Friesian and Ayrshire breeds (SDL 2020). Average milk yields are higher on farms that have specialized dairy breeds (e.g. Holstein-Friesian, Ayrshire etc.) and that use zero-grazing. But within different feeding systems, there is large variation in milk yields, indicating scope for improving other aspects of management (Wilkes et al. 2020b). The quantity and quality of feed resources are widespread

constraints on increasing dairy cattle productivity. The commercial fodder supply sector has been growing in recent years (van Dijk et al. 2018).

2.2 Climate risks and adaptation in the dairy cattle sub-sector

2.2.1 Climate change vulnerability of Kenya's dairy producers

Climate variability and longer-term climate change may have major impacts on Kenya's dairy producers and the dairy value chain as a whole (Table 2).

Table 2. Key climate risks and impacts on Kenya's dairy value chain

	Input and service provision	On-farm production	Trading and processing	Marketing
Higher mean temperatures		Increased likelihood of emergence and re-emergence of livestock diseases (Wetende, et al. 2018)		
High temperatures (hot days)	Reduced fodder quality	Heat stress, especially among improved breeds causing reduced feed intake, milk yields and fertility, longer calving intervals and impacting cow fitness and longevity (King et al. 2006)		
Delayed seasonal onset	Reduced feed and fodder production	Reduced growing season, reduced availability of grazing land and fodder		
Droughts	Low quality and quantity feed and fodder, high feed costs	Feed shortage, inadequate water supply and reduced milk yield (Muli 2000), cattle weight loss (Omondi et al. 2013), increase in diseases and deaths (Anyango 1989), and increased costs of production.	Reduced availability of milk, increase of farm-gate milk price	Reduced milk supply and marketing, increased consumer milk price (Wachira 2019)
Heavy rainfall/floods	Poor access to inputs, reduced feed and fodder quality	Increased disease incidence, lower milk production due to low quality feed, increased costs of production	Damaged infrastructure, reduced milk chilling, transport and procurement	Reduced milk supply and marketing

2.2.2 Adaptation measures

There have been few specific studies on adaptation by dairy farmers in Kenya, but many adaptation options are well-known and are widely promoted as part of dairy development programmes (Table 3). Adoption rates vary for different practices, affected by multiple factors at

household level, including gender (Ochola et al. 2019, Kiff et al. 2017, Wetende et al. 2018). Adoption of adaptation measures also requires an *enabling environment*, including access to finance for investments in inputs, extension services, and access to both input and output markets. Investments further downstream in the value chain can also support dairy farmers' adaptation, including:

- Establishing decentralized milk collection and processing plants to increase milk off-take;
- Long-term contracts with cooperatives and milk processors to provide stable marketing relationships and prices (Ngotho 2020);
- Establishing milk processing plants for powder and ultrahigh-temperature milk to increase off-take and manage seasonal fluctuations in supply and prices;
- Establishment of emergency funds to support dairy development on farm and along the value chain (Mwongera et al. 2019);
- Livestock insurance is also on the rise, especially when dairy cows are purchased on credit finance from a financial institution.

There are many initiatives by farmers, the private sector, NGOs and development partners that are promoting adoption of these practices, but some practices have yet to be broadly disseminated in the dairy sector. In particular, it is clear that gender affects adoption of on-farm measures and engagement with markets in complex ways as well as the potential for women to benefit, and that dairy development initiatives need to explicitly integrate gender-sensitive approaches (Katoya 2017).

Table 3. On-farm adaptation measures

Domain	Adaptation measures	Enabling environment
Feed and fodder supply	• Supplementation with crops and crop residues • On-farm fodder production, including: ▫ drought tolerant varieties ▫ hydroponic (KCB 2020) and irrigated production ▫ fodder trees (Wetende et al. 2018) • Fodder conservation (Mwongera et al. 2019) • Feed and fodder purchase	Access to inputs (seeds, finance) and advisory services Fodder conservation services (Kilelu et al. 2018) Finance to upscale commercial fodder production & storage (van Dijk et al. 2018)
Water supply	• Rainwater harvesting (Njarui et al. 2014)	Access to finance
Pest and disease management	• Regular spraying and vaccination (Wetende et al. 2018)	Access to veterinary services
Animal housing	• Provision of shade (Omondi et al. 2013)	Access to finance and advisory services
Breeding	• Genetic diversity of breeds (Ochola et al. 2019)	Access to breeding services
Economic	• Livestock insurance • Dairy cooperative membership, supply contracts with processors	Suitable insurance products

2.2.3 Knowledge gaps

• At farm level, there are few decisions with long-term effects that lock dairy farmers into irreversible pathways. In this context, the main knowledge gaps relate to how to upscale adoption of measures that benefit both dairy development and adaptation to climate variability in ways that are both inclusive and effective.

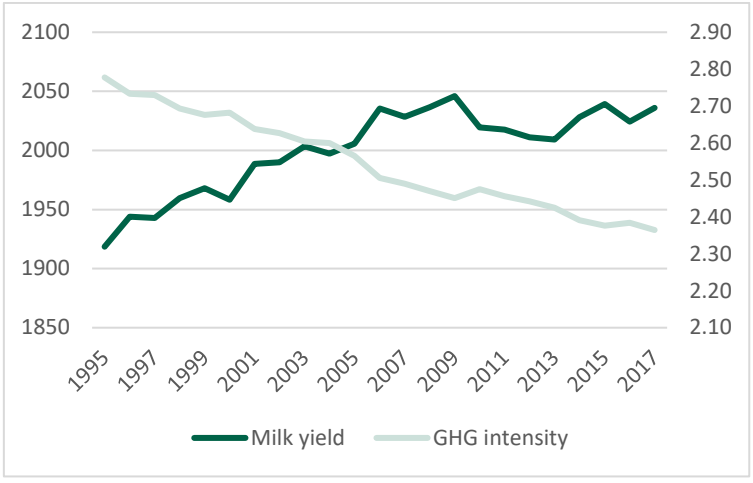
• There has been no assessment for the dairy sector of when and where climate thresholds and climate variability will exceed historical experience. During the period in which climate variability remains within historical experience, incremental adaptation within existing dairy production systems may be sufficient to cope with climate risks. Beyond that, transformative changes may be needed.

• The risks posed by longer-term climate change to major infrastructure investments by input suppliers and processors (e.g. chilling and processing plants) have not been assessed.

2.3 GHG mitigation in the dairy cattle sub-sector

The National Climate Change Action Plan (NCCAP) recognizes the contribution of livestock to national GHG emissions (NCCAP 2018). The State Department for Livestock (SDL) has worked with dairy sector stakeholders to compile a more advanced, Tier 2 GHG inventory for dairy cattle (SDL 2020). The Tier 2 inventory estimated that GHG emissions from dairy cattle were about 3,777 Gg CO_2e in 2010, which is about 26% of total agricultural emissions reported in the SNC. Since then, emissions have increased to 4,836 Gg CO_2e, mainly due to an increase in dairy cattle numbers and partly due to a gradual increase in the average emission factor for dairy cattle. However, the estimated intensity of GHG emissions (kg CO_2e/kg milk) has been decreasing over time (Figure 3). These trends shown by the Tier 2 GHG inventory were not reflected in the mitigation scenarios that informed the first NDC, which used a Tier 1 approach.

Figure 3: Trends in GHG intensity (kg CO2e/kg milk, right axis) and average annual milk yield per cow (litres, left axis) in Kenya, 1995-2017



Source: SDL (2020)

Considerable knowledge on GHG mitigation potential in the dairy sub-sector has been accumulated through the development of Kenya's Dairy NAMA and associated research (SDL 2017). The

Dairy NAMA identified mitigation potential by increasing productivity and reducing the GHG intensity of milk production and promoting biogas on dairy farms, as well as by reducing fossil fuel use in dairy processing enterprises (Table 4). The NCCAP notes that the biogas and energy efficiency measures are captured in the energy sector, not agriculture, where only dairy productivity gains contribute to GHG mitigation. Presented in this way, the contribution of the dairy sector to the NDC mitigation targets is perceived as "not significant at national scale" (MTAR 2018).

A broad range of practices may be relevant to increasing milk yield, including adopting specialized dairy breeds, improved feeding and water provision, animal health (e.g. tick control) and management of calf suckling. Of these measures, recent analysis suggests that adopting improved cattle breeds use and improved feeding consistently and significantly increase milk yields (Bateki et al. 2020). In particular, changing feeding management practices (e.g. promoting balanced use of concentrate according to the lactation cycle) through extension services has been identified as a key GHG mitigation action in central Kenya (Wilkes et al. 2020b). In addition to the mitigation options identified in the Dairy NAMA, further work also suggests that renewable energy (e.g. solar technology) can reduce energy needs in dairy cooperatives (USAID 2018); that reduction of loss and waste in milk supply chains can also reduce GHG emission intensity (Gromko & Abdurasulova 2019); and that dairy intensification is compatible with forest conservation (Brandt et al. 2018), which has been identified as an important strategy for reducing forest loss due to agricultural expansion in the Kenya CSA Strategy (KCSAS 2017).

Table 4. Mitigation potentials in Kenya's dairy sub-sector

Intervention	Mitigation potential (million tCO_2e)
Increased on-farm dairy productivity (152,000 households*	4.14
Biogas promotion (20,000 units)*	0.98
Energy-saving from the dairy processing plant retrofit (151 plants)*	2.96
Reduction in milk loss and waste in cooling centers (all national milk)**	1.70

* SDL (2017); ** Gromko & Abdurasulova (2019).

Dairy farmers commonly face multiple constraints in adopting mitigation practices, including:

- Lack of access to finance for upfront investments (e.g. improved breed cows, fodder cultivation, biogas) and operational costs (e.g. hay, concentrates);
- Lack of access to extension services, especially for women;
- Lack of control over cows and income from milk sales likely constrains women's incentives to improve production practices.

There are many examples of initiatives in Kenya that have shown ways to overcome specific constraints, including:

- Access to finance, e.g. savings groups; making farmers' milk supply records visible to financial institutions (Odhong' et al., 2019);
- ICT-based extension, e.g. i-Cow and other cell-phone based information services (Makau et al. 2018; Marwa et al. 2020);

- Gender interventions, e.g. Gender Action Learning System (IFAD 2019), and the gender mainstreaming methods developed by several dairy development initiatives (Njuki et al. 2013; Vi Agroforestry 2018).

Many of these solutions have been implemented at small scale in various dairy sector initiatives, such as NGO or private sector programmes, but have yet to be broadly implemented in the dairy sector. Kenya Dairy Board is elaborating a corporate gender strategy, which aims to further support gender mainstreaming in the sector.

2.4 Up-scaling climate-smartness in the dairy sub-sector

The dairy sub-sector has been a focus of interventions to increase productivity since the Smallholder Dairy Project in the late 1990s (see http://www.smallholderdairy.org). Climate-smart technologies for dairy production are generally well-known and have been documented by the Kenya Climate Smart Agriculture Project (KCSAP) (Onyango et al. 2019). More recently, several initiatives have provided support to dairy farmers at scale, including:

- **Dairy processors:** Major processors, including Brookside, New KCC, Meru Central Dairy Co-operative Union and others, have been providing extension and advisory services to their suppliers using different extension models (Odhong' et al. 2018).
- **Private sector:** Numerous private sector companies are providing services to the dairy sector, and several commercial banks have dairy credit lines.
- **International NGO and donor projects:** Recent large-scale dairy development projects include the East Africa Dairy Development program, Smallholder Dairy Commercialization Project (SDCP), Kenya Agricultural Value Chain Enterprise project and ongoing programmes of SNV Netherlands, the Livelihoods Fund as well as numerous Kenyan NGOs.

Table 5 provides a partial list of recent and ongoing projects in the dairy sub-sector. Among current projects, KCSAP has prioritized the dairy value chain in 66 out of the project's 73 target wards, and the National Agricultural and Rural Inclusive Growth Project (NARIGP) has prioritized the dairy value chain in 17 out of 21 target counties.

Table 5. Selected ongoing dairy sub-sector projects

Project	Development partner
National agriculture and rural growth inclusive project	World Bank IDA
Kenya Climate Smart Agriculture Project	World Bank IDA
Improved Food Safety, Quality and Value Addition in the Dairy and Horticulture Sector	Danish Veterinary and Food Administration / Dairy without Borders
Programme For Rural Outreach of Financial Innovation Technologies	IFAD
Production, utilization and on-farm upscaling of sweet Lupin cultivars as feed for small-scale dairy cattle Production	USAID
Identification, evaluation and promotion of alternative forages to support smallholder dairy production in Western Kenya	USAID
Molasses urea mineral blocks for feed supplementation	USAID
Rift Valley Fever diagnostic test evaluation in Kenya	USAID

Source: NAIP (2019)

A feature of most recent project-based interventions is that technical support to individual farmers is coupled with strengthening market linkages, including both input supply and access to output markets. Cooperatives are also often playing important roles in both input and output

market linkages, but not all dairy farmers are cooperative members. An increasing number of projects focus on engaging the private sector in developing dairy production and marketing.

One particular focus of the Dairy NAMA, proposed by SDL, is its innovative financing strategy, whereby it is proposed to use public funds – in a combination of technical assistance grants, low-interest loans and loan guarantees – to leverage private sector investment in low-emission, climate resilient dairy development. The intention of this financing strategy is to escape the historical pattern whereby the gains made through international donor projects often slow down when the projects end. Because growth and transformation in the dairy sector depends on collaboration between multiple stakeholders (MPs) in dairy, finance, input supplies, ICT and other fields, SDL has also initiated a Multi-Stakeholder Platform (MSP) to stimulate and coordinate climate smart actions across the sector.

2.5 Policy alignment and implementation

Climate smart dairy development is well aligned with the current policy frameworks for both agriculture and climate change. The dairy sub-sector is prioritized as a value chain with high transformation potential in the Agriculture Sector Growth and Transformation Strategy (ASGTS) and the National Agriculture Investment Plan (NAIP) (Text Box 1).

Text Box 1: The dairy sub-sector's roles in the ASGTS and NAIP Flagships
ASGTS Anchor 1: Increase small scale farmers' incomes
ASGTS Anchor 2: Increase agricultural output and value added
NAIP Flagship 1: Target ~1 million farmers in ~40 zones (initially) producing crops, livestock and fish served by ~1,000 farmer-facing SMEs; increase milk yields by 1% per year.
NAIP Flagship 2: Shift nationwide subsidy programme focus to empower ~1.4 million registered high-needs farmers to access a wider range of inputs from a variety of providers, enabled by digital service delivery. Increase dairy cattle among high-needs farmers to end hunger.

Potential contributions of the dairy sector to GHG mitigation are recognized in the National Climate Change Action Plan (2018-2022, NCCAP 2018), with dairy mitigation contributing 15% of total agriculture sector emission reductions identified. Kenya's first NDC proposed that adaptation and GHG mitigation in the agriculture sector shall be promoted in line with the national CSA framework. The KCSAIF sets out a policy focus for emissions management not on absolute emissions but on production efficiency, leading to increased output per unit of emission. A strong relationship between productivity and GHG emission intensity and significant potential for productivity increase have both been documented for Kenya. KCSAIF prioritizes several lines of action relevant to adaptation needs in the dairy sector, including promoting access to and use of adaptive technologies and creation of an enabling environment through value chain development, and access to services and finance. The National Adaptation Plan also prioritizes actions in fodder supply and storage, market access, breeding management of livestock to adapt to climate change, and promotion of climate-smart agriculture. The proposed dairy NAMA is well aligned with the KCSAIF, the NCCAP and the NAP.

In addition to continuing to seek finance for the Kenya's Dairy NAMA, there are three areas where SDL can work with stakeholders in the dairy sub-sector to progress towards national climate change objectives.

(i) Mainstreaming gender: KCSAIF recognizes the importance of creating awareness and capacity building for women, youth and venerable groups. In the dairy sector, it is clear that gender inclusion needs to be addressed as a central part of climate smart dairy development, not as an add-on or 'cross-cutting issue' (Wilkes et al. 2020a). Working towards this will require collaboration among stakeholders, and coordination is one of SDL's mandates. Kenya Dairy Board, the semi-autonomous government agency responsible for the dairy sector is in the process of adopting a gender strategy. SDL should investigate how it can provide support.

(ii) Stakeholder coordination: National policy frameworks follow sectoral mandates. It is clear, however, that dairy development requires cross-sectoral collaboration, including in particular private sector engagement with the dairy industry, energy companies and the financial sector. In line with SDL's coordination mandate, SDL should continue to promote stakeholder collaboration on climate-smart dairy development through MSPs and other platforms.

(iii) Monitoring and reporting and MRV: SDL has begun a process of continuous improvement for the dairy GHG inventory. Further improvements are required to enable the inventory to accurately track change in emission intensity. These improvements would also benefit national statistics in the dairy sector. There are many ongoing initiatives in the dairy sector and the contribution of these initiatives to adaptation and mitigation is not being tracked or reported in the national MRV system. Near-term actions for SDL to improve monitoring and reporting of climate-smart dairy development are discussed in Chapter 6.

3 BEEF CATTLE SUB-SECTOR

3.1 Overview

The beef cattle industry is the second largest agricultural subsector by marketed value, at around 21% of recorded market value (ASGTS 2019, producing not only beef but also hides used in the leather industry. Beef cattle make major contributions to the economy and livelihoods, especially in arid and semi-arid lands (ASALs), which constitute about 80% of Kenya's land mass (Amwata et al. 2015). Cattle is the most important source of red meat, accounting for 77% of Kenya's ruminant off-take for slaughter (Farmer & Mwika 2012). Kenya has about 13.5 million head of beef cattle, of which 95.8% are indigenous breeds, with 2.4 million households keeping beef cattle (KNBS 2019). More than 75% of cattle are kept by pastoralists who supply about 60-65% of meat consumed in Kenya (Farmer & Mwika 2012). Kenya has a meat supply deficit, and a significant proportion of meat (ca. 20-25%) comes from livestock raised in neighboring countries (e.g. Ethiopia, Somalia, Tanzania and Uganda) (Wakhungu et al. 2014).

Production systems for beef cattle in Kenya include extensive grazing systems (both pastoralism and ranching), semi-intensive grazing (agro-pastoralism), and a small intensive (feedlot) subsector (Table 6). Kenya's meat market is primarily urban (KMT 2014). Nairobi and Mombasa consume about 17% of the total volume, but this is projected to increase to 40% by 2050. Beef prices

have been increasing in recent years. To meet rising domestic demand, the number of cattle slaughtered has been increasing (Table 7). It is estimated that two thirds of Kenya's meat production goes through formal channels, while one-third occurs informally. Estate butcheries are the preferred outlets for the majority of consumers (KMT 2014). Beef exports have also increased in recent years, mostly as frozen beef, but remain relatively small at 1543 tonnes with an export value of US$6.3 million in 2018, and lag behind the value and volume of sheep and goat meat exports and the value of tanned cattle hide exports (www.trademap.org). The main importers of Kenyan beef are low-income countries in Africa (e.g. South Sudan, Tanzania, D.R. Congo), but some sales to UAE, Vietnam and China have begun.

Table 6. Characterization of beef cattle production systems in Kenya

Beef Cattle Production Systems	Extensive pastoralism	Extensive Ranching	Semi-intensive	Feedlot (Intensive)
Proportion of farms (%)	34%	11%	54%	1%
Breeds Kept	East Africa Zebu, Boran Sahiwal	Improved Boran and exotic	crossbreeds and pure exotic breeds	Boran, Sahiwal and Zebu crosses and exotic breeds
Average heads per household	50	150	10 -12	-
Feeding management	Grazing on natural pastures	Natural or cultivated pasture with some supplemented feed	Grazing on communal areas and crop residues as feed supplements	Concentrates and feed supplements
Yield per animal (kg carcass weight per head)	125	240	na	Na
Market	Urban markets, bulk of domestic supply	Local niche markets and international market	Middle men operating in local primary markets and making a link with abattoirs	Formal channels, niche markets in urban areas and export markets.

Na: not available. Source: (FAO n.d.)

Table 7. Cattle and calves slaughtered in formal channels, 2013-2019 (Unit: million head)

Item	2013	2014	2015	2016	2017	2018	2019
Cattle and calves	2.1473	2.0767	2.2745	2.4602	2.5900	2.7817	3.0808

Source: KEBS (2020)

Several challenges constrain the development of Kenya's beef sub-sector, including:

- Multi-dimensional poverty and high sensitivity of ASAL livestock systems to climate variability and climate change;
- Low productivity, due to high mortality rates due to inadequate disease surveillance, prevention and control; inconsistent supply of quality feed and water due to seasonal weather changes and poor rangeland management; and inadequate access to services and extension support;
- Weak market linkages for many producers, coupled with low market information access; limited access to export markets due to inadequate disease control.

3.2 Climate risks and adaptation in beef cattle sub-sector

The majority of cattle are raised in the ASALs of Kenya, which cover 29 counties with a population of about 16 million people (RoK2012a). These areas are highly vulnerable to climate change and climate variability, which contributes to high levels of multi-dimensional poverty, land degradation and human conflict, among other impacts. Drought is the most significant risk in ASAL areas, with major impacts on livelihoods, the economy and the environment (RoK 2012b). Historically, the frequency of meteorological drought has been increasing in ASAL areas (Ayugi et al. 2020), though future trends are less certain. Increasing high temperature days (>30°C) are projected, which has led to decreasing cattle populations in several ASAL counties in recent decades, because cattle suffer from heat stress (KMT 2018) Climate trends may also increase the frequency and severity of pest and disease outbreaks (Grace et al. 2015). Diseases can result in reduced milk production, loss of weight, delayed maturity age, decreased reproductive rates, and increased mortality rates (Onono et al. 2013b), and some diseases carry risks for human health. Pests also affect the quality and value of cattle hides (World Bank Group 2015).

Increasing resilience to climate risks in the ASAL regions requires a holistic approach to development, as set out in the *Vision 2030 Development Policy for ASALs* and the *Common Programme Framework for Ending Drought Emergencies*. Within the livestock sector, there are four promising adaptation strategies:

(1) Improved rangeland management: Several factors affect grazing practices and resulting changes in vegetation and land degradation, including reduced grazing land availability due to changes in land tenure, arable land development, increasing livestock populations, as well as climate change (Kioko & Okello 2010). Natural pasture degradation is a key limitation on livestock production in ASAL areas. Maintaining livestock mobility and grazing management are important measures to cope with climate variability and maintain vegetation and land health (Nkonya et al. 2018). In pastoralist areas, this depends on secure land and resource rights (e.g. communal land tenure, conservancies, by-laws), and locally appropriate institutional arrangements, which should vary according to local context (Senda et al. 2020). Maintaining mobility and planned grazing may also require investments in water infrastructure. Other technical measures include rangeland enclosures, reseeding by introducing locally-adapted high-value pasture and tree species, control of invasive alien species, ripping of soil crust, seasonally protected pasture zones and restoration of structural soil and water conservation infrastructure (Kinyua et al. 2010, Mureithi et al. 2016).

(2) Improved animal health management: Disease control is important for reducing losses due to low productivity and animal mortality, for increasing producers' access to both domestic and international markets and for ensuring consumers' food safety. Disease prevention has been shown to be profitable (Onono & Wieland 2013a), but measures to mainstream disease surveillance and deliver preventive programmes in pastoral areas still require further innovation (Lore 2018). Kenya's legal system for animal health and disease surveillance and control are currently being revised through the Veterinary Public Health Bill, Livestock Bill and draft LITS regulations. Strengthening access to veterinary inputs and services is a priority.

(3) Fodder production: Considering the insufficient native vegetation in ASAL regions, it has been argued that the lack of a national policy for commercial fodder production in ASALs is a major policy gap (Mureithi 2018). Specific suggestions include to integrate fodder production areas in ASAL counties' spatial plans; review and develop supporting policy regulations; strengthen value chain collaboration (e.g. through county level pasture production forums); strengthen access to finance for private investments.

(4) Livestock marketing and trade: Cattle off-take rates in ASALs regions are low. In part this may be due to pastoralists' livelihood and herd management strategies, as cattle are not raised purely for commercial purposes. In part, it is also due to marketing constraints faced by pastoralists and others in the value chain. These constraints include: poor access to markets and marketing information, lack of market infrastructure, community conflicts and low prices, among others. Options to address these constraints that have been proposed and piloted include:

i. Improving livestock keepers' access to market information;
ii. Enhancing collective production and marketing to increase the bargaining power of the farmers,
iii. Facilitating direct linkages between the producer and key buyers who offer reliable prices and consistent markets,
iv. Rehabilitating livestock marketing infrastructure through partnerships with the private sector and community associations and
v. Facilitating the establishment of strategic business partnerships between communities and local authorities, based on public-private partnership models.

Other potentially important adaptation options include breeding to increase adaptive traits and livestock insurance. In theory, different breeds differ in the extent to which they can tolerate climatic extremes (e.g. high temperatures) and tolerate diseases. Additional research is required to identify deployable breeding options that support adaptation to climate risks while improving animal reproduction and growth (Thornton et al. 2008). Index-based livestock insurance is being piloted and rolled out in ASAL areas (KLIP 2018). At present, the scale of adoption is limited, but there is evidence of positive benefits for pastoralists, including the poor (Noritomo 2019, Jensen et al. 2017). Further efforts are ongoing to identify how to increase insurance adoption.

3.3 GHG mitigation in the beef cattle sub-sector

There has been very little research on GHG mitigation options in the beef cattle sub-sector in Kenya. Beef cattle are the largest single source of agricultural GHG emissions, and SDL is interested to identify promising mitigation options to increase the contribution of the agriculture sector to the NDC. Given the high levels of vulnerability in this sub-sector, the focus should be on identifying mitigation co-benefits of adaptation options. Four broad areas to explore can be identified:

(1) Rangeland carbon sequestration: Improved rangeland management can sequester carbon in soils and vegetation. The Northern Kenya Improved Grasslands project provides a practical example of how valuing carbon benefits can support rangeland management by pastoralists (Text Box 2). Other initiatives are also promoting rangeland management at scale in Kenya, but

carbon benefits are not being quantified, and research is ongoing to understand the factors that are favourable for effective upscaled implementation (Nganga et al. 2019).

Text Box 2: Northern Kenya Grassland Carbon Project

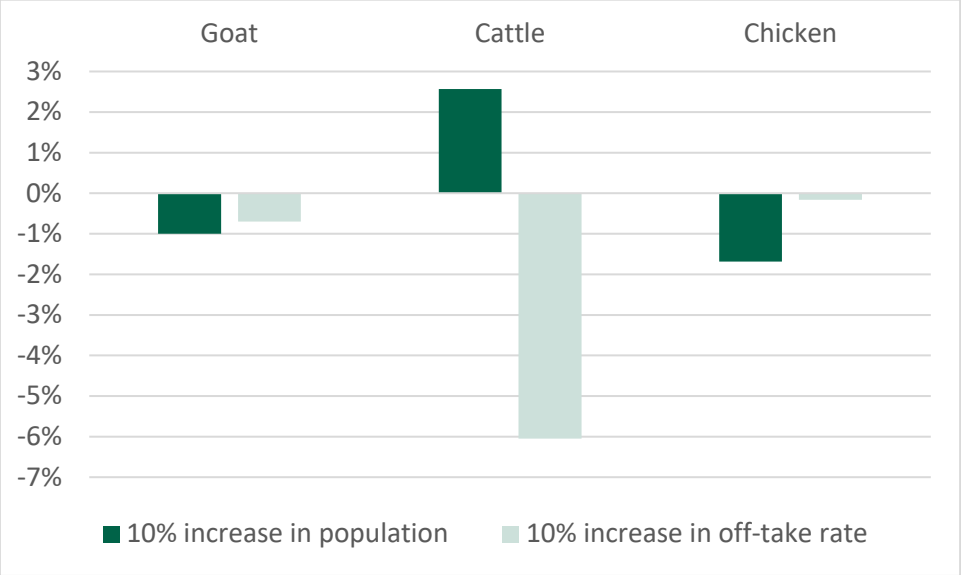
The Northern Rangelands Trust (NRT) is implementing this project in Samburu, Isiolo, Marsabit, and Laikipia counties in partnership with The Nature Conservancy and Soils for the Future, LLC. The NRT's conservancies cover 2 million ha of rangeland. Rangeland management involves implementing planned grazing in each conservancy to promote livestock mobility. This improves vegetation growth which sequesters carbon in soils. Carbon stock changes are estimated through a combination of modelling and direct measurements, with an ex-ante estimate of an average sequestration potential of 0.75 tCO_2e/ha. The project is registered to a voluntary carbon standard methodology. The idea is that revenues from carbon credits can be invested by communities in activities to improve their own welfare.

Source: (NRT, n.d.)

(2) Livestock marketing: The GHG intensity (kg CO_2e / kg livestock product) of cattle production depends on GHG emissions and the amount of meat and other products produced. In more intensive systems, the focus would be on increasing cattle productivity to reduce GHG intensity. In theory, fattening and feedlot operations may have positive effects. At present the scale of these operations in Kenya is very small. It may be worth investigating whether fattening and feedlot operations do in fact reduce the GHG intensity of livestock production when animal emissions, manure emissions and emissions from feed production are all considered. Since fattening farms and feedlots in some areas primarily source from pastoralists, developing the sector could potentially support livestock marketing by pastoralists. Kenya's feedlot sector has not been extensively researched, so it is not possible to assess this using existing data. In extensive systems, increasing cattle off-take rates may also reduce the GHG intensity of livestock production. To examine this potential, a simple model was built of Kenya's livestock sector to estimate the GHG emissions per unit of protein produced.[1] FAO data for 2013 suggest an off-take rate of 11% for cattle in Kenya. If the off-take rate increased by 10% to 12.6%, the GHG intensity of protein produced by content in increase in cattle off-take rates would decrease GHG emissions per unit of protein produced by 6% (Figure 4). This effect is stronger than for goats or chicken because of the large contribution of the cattle population to both GHG emissions and meat and milk protein production. This gives an indication that increasing cattle off-take could be a mitigation option worth investigating further.

[1] Population data and off-take rates were taken from FAOSTAT, GHG emission factors and live weight from IPCC (2019) and protein content of marketed product was estimated using default values in GLEAM. Protein content was estimated for meat, milk and eggs produced by cattle, goats and chicken.

Figure 4: Modelled percentage change in GHG intensity (kg CO_2e / kg protein) of the livestock sector due to increasing population or increasing off-take rates



(3) Feed: Livestock feed distribution in Kenya is determined by the agro ecological zones of the country. The ASALs areas are in agro-climatic zones IV, V, VI and have an average rainfall ranging from 300-800 mm per year. Rangelands are further characterized by poor vegetation cover, fragile soils and high temperatures, with limited biomass yields and low digestibility, especially in the dry season. Feeding low-quality and low-digestibility feeds result in higher enteric emissions in beef production. Improvements in feed and fodder supply in ASALs are a priority for adaptation objectives, but may have mitigation co-benefits, as improved feed quality, digestibility, and better matching protein supply to animal requirements could have meaningful impacts on reducing the GHG footprint of the beef industry (Andeweg & Reisinger 2013).

(4) Disease control: Animal diseases reduce cattle productivity and reproductive efficiency, as well as causing mortality. In theory, reducing morbidity and mortality by preventing disease can reduce the GHG emission intensity of livestock production (MacLeod et al. 2018). The difficulty with developing this approach is that robust data is needed on disease prevalence and its impacts on animal performance. There are several initiatives in Kenya to improve disease surveillance, to research disease impacts and to deliver effective preventive measures. Where there is evidence that preventive measures are feasible and effective, it may be worth exploring whether data exists or could be collected to enable quantification of the GHG benefits.

3.4 Up-scaling climate-smartness in the beef cattle sub-sector

Interventions targeting the ASAL regions where most beef cattle are raised are multifaceted and mainly target initiatives that support improved livelihood options. There are many such initiatives implemented by government agencies like the National Drought Management Authority (NDMA), NGOs and county governments. The NCCAP highlights the County Climate Change

Funds in Garissa, Isiolo, Kitui, Makueni and Wajir as important innovations to enable and support community-planned, demand-driven adaptation investments (NCCAP 2018). Specific to the beef cattle sub-sector, there are also examples of initiatives that are supporting rangeland management, disease control and livestock marketing at scale.

There are various arrangements for community-based rangeland management in Kenya. One example is the Northern Rangelands Trust (see Text Box 2 above). International union for conservation of nature (IUCN) has begun implementing a GCF project, which will implement ecosystem based adaptation in two areas covering 2.5 million hectares in 11 counties (IUCN 2019). There are many other community-based initiatives elsewhere in the country. The 'Restoration of degraded land for food security and poverty reduction in East Africa and the Sahel: Taking successes in land restoration to scale project', led by the World Agroforestry Centre and funded, has been researching the conditions and requirements for upscaling, which should provide important lessons to guide future efforts.[2] Rangeland reseeding technologies have also been developed by Kenya Agriculture and livestock research organization (KALRO) through the National Agricultural Research Project II (NARP II, 1998-2004) and Kenya Arid and Semi-Arid Land project (KASAL, 2007-2012) (World Bank 1997). County governments of Makueni and Taita and NGOs in ASAL aeras are involved in similar projects. Improving the availability of information on the economic and other benefits of reseeding may assist in promoting further adoption.

Kenya is currently revising the legal framework for animal health and livestock marketing through the Animal Health Bill, Veterinary Public Health Bill, Livestock Bill and Livestock and Livestock Products Marketing Board Bill. These legal and policy reforms have potential for large-scale change across the beef sector. They aim to bring Kenya's animal health system in line with international standards, and strengthen livestock marketing, vaccine production, and tsetse and trypanosomosis eradication. Adaptation and mitigation benefits will depend on delivery in the rural areas. Initiatives scaling up access to animal health services include disease surveillance initiatives by the Ministry of Agriculture and Kenya Wildlife Services (Falzon et al. 2019), and private sector initiatives such as the social enterprise, SIDAI, established by FARM Africa, which runs a network of centers providing livestock agro-inputs and services (Farm Africa n.d.).

Recent research has identified a range of interventions that could strengthen the adaptation benefits of livestock marketing in Kenya's beef sector (PRISE 2019). Initiatives addressing these options at large scale were not identified in this brief review.

3.5 Policy alignment and implementation

The beef sector is identified as a high priority sub-sector in the ASGTS and NAIP. The ASGTS proposes actions to support pastoralist to transition from highly diversified subsistence production to more specialized and market-oriented output in higher-yield value chains. The target of

[2] See http://www.worldagroforestry.org/project/restoration-degraded-land-food-security-and-poverty-reduction-east-africa-and-sahel-taking

this is to increase farmers' incomes by increasing access to markets via 1,000 SMEs and lowering the cost of inputs through a restructured subsidy system. To improve market access to both inputs and off-take, the Government will drive rapid transformation by working with local change agents across the country. Adaptation in ASALs is also supported in KCSAIF and the NCCAP and specific measures are set out in the Adaptation Technical Analysis Report (ATAR), including integrated development in the ASAL areas, rangeland rehabilitation, livestock marketing and research on the adaptability of livestock breeds (ATAR 2018).

Given that beef cattle are the largest source of GHG emissions in Kenya's livestock sector, the lack of identified mitigation options is a gap in the NCCAP Mitigation Technical Analysis Report (MTAR 2018). In line with KCSAIF, mitigation in the beef sector should focus on the mitigation co-benefits of adaptation strategies, and explore the potential for mitigation benefits to leverage support for upscaled implementation of adaptation measures.

4 SMALL RUMINANTS SUB-SECTOR

4.1 Overview

Small ruminants (sheep and goats) are a key sub-sector of Kenya's livestock and agriculture sector. Kenya has 46 million sheep and goats, 58% of which are goats and 42% sheep (FAOSTAT 2020). Small ruminants not only provide livestock keepers with regular cash income from meat, milk and manure, but also serve as insurance in case of emergencies (Kosgey et al. 2008). Production systems are often extensive and involve grazing and browsing of available natural pastures (Mahgoub et al. 2005).

Key products from the small ruminant sub-sector include meat and milk (Table 8), as well as hides used in the leather industry. Sheep and goat meat account for about 30% of Kenya's red meat consumption (MoALF 2019). 67% of Kenya's red meat is marketed through the formal channel. Many Kenyan households prefer to consume small ruminants' meat over beef (Juma et al. 2010). Slaughtered volumes and market prices have been increasing in recent years (Table 9). In terms of exports, the volume and value of Kenya's goat and sheep meat exports in 2018 reached USD$ 34 million, which was more than 4 times greater than the value of Kenya's beef exports. The main export market for sheep and goat meat is the Middle East.

Table 8. Small ruminant population, meat and milk production and trade

Year	Sheep and goats (head)	Meat production (tonnes)	Trade value (1,000 US$)		Milk production (liters)
			Import	Export	
2014	44,595,265	109,387	19	12,581	342,900
2015	41,889,581	94,554	4	14,999	321,800
2016	45,729,676	78,368	82	16,144	344,300
2017	44,443,561	51,443	3	31,163	322,600
2018	46,196,474	62,404	3	34,745	314,224

Sources: Population, meat and milk production from FAOSTAT. Trade values from KNBS cited in www.trademap.org.

Table 9. Sheep and goat slaughtered 2013-2019 (million head)

Item	2013	2014	2015	2016	2017	2018	2019
Sheep and goats	6.0848	6.385	6.5608	8.2202	9.2067	10.2476	11.3027

Source: KNBS (2020)

The small ruminant marketing systems in ASALs involve several players including producers, intermediaries, traders and numerous other market participants. Animals are moved from grazing areas to primary and secondary markets along key trading routes and corridors to terminal and export markets. The prices of live animal are also variable and based on a bargain at the market.

The quantity and quality of grazing land are often insufficient to meet the nutrient requirements of sheep and goats. Resettlement, population growth and privatization of land have made migration more difficult. Especially during the dry season, insufficient feed and water result in low production (animal growth and milk yields), poor reproductive performance and reduced livestock health (Katiku et al. 2013). Other constraints include the lack of markets and marketing systems, a lack of market information, poor infrastructure in livestock markets and the slaughter house leading to increase transaction cost, insecurity on the roads also reduces market participation and low prices due to exploitive livestock brokers.

4.2 Climate risks and adaptation in small ruminants

4.2.1 Climate change vulnerability of Kenya's small ruminant sector

Because small ruminants are less vulnerable to climate risks and the effects of longer-term climate change (e.g. high temperatures), there has been a notable shift in the preference of pastoralists towards small ruminants rather than cattle. In comparison to cattle, small ruminants have demonstrated their ability to better cope with the effects of climate change, among others due to their ability to feed on low-quality feedstuffs, cope with heat stress and recover from drought. Not surprisingly, small ruminants have thus been prioritized within the livestock subsector, contributing to food security in the context of climate change (Kenya Vision 2030).

However, small ruminants are also affected by climate variability and climate change. Most small ruminants are raised in the ASAL regions, although a significant proportion are also found in the highland mixed crop-livestock systems. Climate risks include increased average annual temperature and altered seasonal rainfall patterns in Kenya, which may delay the onset of vegetation growing seasons, as well as drought and heavy rainfalls and floods (NCCAP 2018). These climate risks may affect grazing land/production of fodder, availability of water resources, and livestock health (Table 10).

Table 10. Climate risks and impacts on small ruminant production

Climate risk	Small ruminant production
Delayed seasonal onset	Reduced growing season; reduced availability of grazing land and fodder; feed shortages
Increased frequency and duration of droughts	Reduced quantity and quality grazing land/fodder; feed and water shortage; resulting in low livestock productivity and high susceptibility to diseases (Recha & Radeny 2017), increased livestock morbidity and mortality (Moenga et al. 2016).
High temperatures incl. hot days	Heat stress, especially among improved small ruminant breeds, can cause reduced feed and water intake, increase energy required for maintenance and, as a result, reduce growth and milk yields, reduce fertility and impact the immune system

4.2.2 Adaptation measures

Indigenous goats are well-adapted to the local climate and can utilize low quality forages (e.g. shrubs) particularly well (Katiku et al. 2013). Thus, one adaptation measure is **cross-breeding** of goats and sheep with more climate-resilient breeds, such as *Galla* goats or *Red Masaai* sheep (Recha & Radeny 2017). Cross-breeding higher yielding animals with indigenous breeds enables the farmer to have more climate-resilient livestock whilst also producing more milk and meat than pure indigenous breeds. Combined with **improved small ruminant management practices** (e.g sheep and goat husbandry, housing, fodder development and conservation, animal health management), cross-breeds are better able to cope with low quality feedstuffs, can better withstand heat stress, recover more quickly from drought due to faster growth and thus reach a market weight more quickly. Furthermore, they are more resilient to disease burden (Recha & Radeny 2017).

Other on-farm adaptation measures include grassland improvement/rehabilitation, integration of legumes to improve the nutrient content of grasslands, planting of fodder trees, conservation of feed (e.g. hay) for dry periods, provision of shade for livestock, adjustment of livestock numbers to the available grassland, rainwater harvesting and water management (Omondi et al. 2013). Experiences within the CCAFS Climate-Smart Villages project (Recha & Radeny 2017) show that these measures, implemented through community-based organizations, can help farmers increase their income (e.g. by the sales of livestock at higher prices) and contribute to food security (Gilbert 2015). However, for farmers to adopt these measures, an **enabling envi-**

ronment is required. The Climate-Smart Villages project demonstrates the need for farmer guidance through extension services, self-help groups and/or other forms of community/group-based organisations (Ngigi et al. 2015). Working with community-based organisations helped the project achieve greater adoption rates of small ruminant management interventions due to the facilitation of farmer investments, sharing of information and the facilitation of new markets (Recha & Radeny 2017). Access to services and inputs, credit and markets further contribute to an enabling environment for the adoption of adaptation measures. Therefore, in addition to on-farm adaptation measures, measures required to create an enabling environment for small ruminant keepers include:

- Improvement of infrastructure to assist access to inputs, services and markets;
- Improvement of access to veterinary services;
- Improvement of disease control (among others by vaccinations) and surveillance;
- Establishment of fodder banks;
- Input subsidies for farmers;
- Establishment of emergency funds;
- Credit schemes;
- Income diversification options;
- (Index-Based) Livestock insurance;
- Improved access to markets, contract marketing

(see Thornton et al. 2009, Omondi et al. 2013, Ngigi et al. 2015, FAO 2017, Khalai & Kasyoka 2019).

There are dairy and meat breeds of both sheep and goats. More systematic research is required to understand differences in climate change vulnerability, and potential adaptation measures, between dairy and meat breeds in different agro-ecological zones and production systems. Dairy goat husbandry has gained popularity in recent years, but marketing of goat milk is still traditional (Ogola & Kosgey 2019). The potential for formal goat milk marketing and its potential role in contributing to farmers' resilience to climate change require further investigation.

4.3 GHG mitigation in small ruminants

Small ruminants contribute about 20% of enteric fermentation and manure management emissions in Kenya (FAOSTAT 2020, based on Tier 1 calculations). Greenhouse gas emission intensity for small ruminant milk and meat production in Sub-Saharan Africa is estimated at 6.9 kg CO_2/kg FPCM and 31.5 kg CO_2/kg carcass weight (CW) respectively. Emission intensities are relatively high, mainly due to low livestock productivity, which can be explained by low feed quality and poor animal health (Gerber et al. 2013a). Improving animal and herd productivity can potentially reduce greenhouse gas emissions reduced by 27 – 41% (Gerber et al. 2013b).

There is little evidence about GHG mitigation potential with small ruminants in Kenya. However, many adaptation measures may have mitigation co-benefits due to improved animal and herd efficiency. Cross-breeding of indigenous small ruminants (e.g. with the Galla goat or Red Masaai sheep) can improve climate resilience and productivity, and therewith reduce greenhouse gas intensity (Recha & Radeny 2017). Further potential mitigation measures for the small ruminant sub-sector include:

1. **Improve feed quality, animal and herd productivity and therewith reduction of slaughter age.** Reducing the slaughter age of small ruminants, by improving feed quality and animal productivity, has the potential to reduce greenhouse gas emission intensity by 34% (Nash et al. 2016);
2. **Animal health management** to enhance animal and herd production efficiency (KCSAS 2017);
3. **Improved manure management** can contribute to soil quality, improved grassland production and recycling of nutrients and energy (Recha & Radeny, 2017);
4. **Increased off-take:** The emission intensity of small ruminant production also depends on off-take rates. The model described in Figure 2 suggests that a 10% increase in goat off-take rate (from 15% to 16.7%) could decrease the GHG intensity of goat production by about 4%. Figure 2 also suggested that a 10% increase in the goat population, with other species populations remaining constant, could decrease the GHG intensity of livestock production in Kenya by 1%. This is because goat production has a lower GHG intensity than cattle production.

Further exploration of mitigation potential in the small ruminant sector should quantify GHG emissions using the IPCC Tier 2 approach for each species in different production systems; identify and assess sector development and adaptation options with potential mitigation co-benefits; and engage with sub-sector stakeholders to explore the potential for upscaling of promising options.

4.4 Up-scaling climate-smartness in small ruminants

There are several initiatives promoting improved breeds in Kenya. The Africa Galla goat is hardy, resistant to gastro-intestinal parasites and can feed on different types of vegetation. The Galla goat is known to gain weight fast after periods of drought. Just like the Galla goat, the red Maasai is rated highly by both agro-pastoral and pastoral farmers in terms of drought and heat tolerance (Kosgey 2004). The Red Maasai sheep is also resistant to gastrointestinal worms (FAO 2007). In 2011, the International livestock research institute (ILRI) introduced improved Red Maasai sheep bred at ILRI's Kapiti ranch in Eastern Kenya and Kajiado county to increase resilience of small ruminant production. Crosses between Galla and Small East African goats and exotic breeds were widely promoted by a FARM Africa programme some years ago, which demonstrated a successful model for breed upgrading at scale (Peacock 2007). CCAFS also implemented the 'Sustainable small ruminant breeding program for climate smart villages in Kenya' project. The project introduced improved strains of resilient but more productive indigenous breeds of Gala goats and Red Masai sheep for cross breeding with local breeds (Ojango et al. 2015). Integrated breeding, feeding, animal health and husbandry services are provided by several NGOs, and the Dairy Goat Association of Kenya serves as a platform for its members. Small ruminants are also prioritized in some of the counties supported by KCSAP and NARIGP, and are a focus for IFAD's forthcoming Livestock Commercialization Project. Further initiatives upscaling adaptation measures at scale in Kenya were not identified in this brief assessment, but should be explored in the future to understand the support that their initiatives may require.

4.5 Policy alignment and implementation

Small ruminant production is aligned with both national agriculture and climate change objectives. The ASTGS identifies sheep and goat value chains among the top 13 value chains with the highest potential. Small ruminants are also more resilient to climate risks than cattle, and are more easily adopted by poorer households and vulnerable groups. In the ASTGS, sheep and goat value chain feature among the top 5 value chains in Rift Valley, Northern ASALs and Central ASALs. Other than the Rift valley, the other regions where the sheep and goat feature are ASALs. This implies that the development of the sheep and goat value chain will be closely linked to the development of the ASAL areas. The ASTGS encourages continuation of successful activities in these value chains that are relatively well organized and coordinated, rather than those that require transformation. KCSAIF, as the main framework for implementation of Kenya's NDC in the agriculture sector, lists generic actions relevant to small ruminants, but does not list any actions specific to small ruminants. Progressing adaptation and mitigation in the small ruminant sector will require:

(1) Improved understanding of currently available adaptation options for small ruminants and their mitigation co-benefits;
(2) Improved understanding of initiatives currently or planning to promote adaptation options at scale;
(3) Coordination with stakeholders in the sector, to identify how the government can better support their needs.

5 POULTRY SUB-SECTOR

5.1 Overview

There has been tremendous increase in poultry population (i.e. broilers, layers, local chicken and others) from 30.2 million in 2010 to 57.7 million in 2019 (SDL 2020b) (Table 11). It is worth noting a faster growth of broilers numbers, which may be due to increased demand for white meat due to lifestyle changes and structural changes in the sector (e.g. well established integrated breeding companies, small and commercial production farms, and low and high end market access) (Carron et al. 2017). Production of both eggs and meat have increased by 22% and 12% per annum, respectively, and the total value of egg and meat products have increased at even higher rates (Table 12).

Table 11. Poultry population in Kenya from 2010 to 2019

Year	Broilers	layers	indigenous chicken	Others*	TOTAL
2010	2,213,750	2,675,571	24,538,906	779,568	30,207,795
2011	2,600,924	2,847,225	26,219,935	684,243	32,352,327
2012	2,842,440	3,076,808	27,967,976	689,283	34,576,507
2013	2,745,188	3,675,425	32,569,198	878,991	39,868,802
2014	4,069,729	3,693,283	33,088,442	890,762	41,742,216
2015	3,117,554	3,716,911	34,666,188	909,841	42,410,494
2016	3,056,747	4,161,289	36,578,441	922,181	44,718,658
2017	3,819,515	4,237,188	40,067,874	943,719	49,068,297
2018	4,534,600	5,261,279	42,791,309	1,089,623	53,676,811
2019	4,878,517	5,460,174	46,096,114	1,240,160	57,674,965

* Turkeys, geese and ducks

Table 12. Poultry sector output, 2012-2019

Year	Eggs (Trays)	Total value (Kshs)	Meat (Kgs)	Total value (Kshs)*
2012	197,062,582	59,118,774,730	48,393,000	19,357,200
2013	170,213,441	51,064,032,250	28,692,500	11,477,000
2014	171,183,941	51,355,182,240	81,042,700	32,417,100
2015	46,912,836	15,444,039,488	64,308,680	28,766,710
2016	50,989,335	17,129,847,558	45,937,900	20,199,800
2017	52,926,249	18,288,881,336	106,978,034	48,206,502,538
2018	426,539,668	127,961,900,400	96,789,126	43,615,170,874
2019	501,811,374	177,894,142,000	89,553,383	43,068,691,553

* The data are from SDL, and the step-change in meat value from 2016-2017 is likely due to methodological reasons.

This rapid growth is driven by rapid urbanization, growth of the middle class, a rise in the number of quick service restaurants in urban areas and growing demand for animal protein (Vernooij et al. 2018). Consumption of poultry meat by high, middle and low income households has increased more rapidly than consumption of red meat. This has led to change from free range production with minimal management to more intensive production systems with higher levels of management, high performing breeds, and better quality feed. For example, from 2010 to 2019 there has been a reduction of 1% in the proportion of local chickens in the poultry population, while the broiler population increased by 1.1% over the same period. The shift to intensive production system could be attributed to decreasing land sizes (e.g. in Kiambu county), rearing high producing breeds (improved indigenous chicken, layers and broilers) and commercialization of poultry farming. Poultry production is common in rural settings by the rural poor (mostly

women and children) (Khobondo et al. 2015). There is evidence that extreme poverty and hunger can be reduced significantly when chickens are raised for meat and eggs by poor households, so poultry can contribute significantly to national food and nutrition security objectives.

5.2 Climate risks and adaptation in the poultry sub-sector

5.2.1 Effects of climate risks on poultry production

Kenya faces a number of risks from climate variability and change. The key climatic hazards include droughts, delayed seasonal onsets or heavy rainfalls leading to floods and rising sea levels (NAP 2016). Climate change is a threat to poultry production because of the negative impact on the quality of feed crop and forage, water availability, poultry production, diseases, biodiversity, agroecological zone, food security and heat stress (Table 13) (Rojas-Downing et al. 2017).

Table 13. Climate risks and their effects on poultry production

Climate risk	Poultry production
Floods	Flood waters favorable for multiplication of disease through microorganisms in the environment, feed and animals. Moist conditions spoil feed. Disease risks include avian botulism and brooder pneumonia (Othenio, 2016).
Heat stress	Lower feed nutrient utilization, reduced feed intake, compromised production, low reproduction, deteriorated health, and high mortality

The effects on commercial production and poultry value chains have not been well documented. Climate risks and global warming directly influence processing, transportation, storage and distribution activities in the poultry value chain. However, information on climate risks (drought, flood and increasing temperatures) and their impacts specific to Kenya could not be identified.

5.3 Adaptation Options

Adaptation measures involve production and management system modifications, breeding strategies, institutional and policy changes, science and technology advances, and changing farmers' perception and adaptive capacity (IFAD 2020). Therefore, adaptation strategies can improve the resilience of poultry productivity to climate change (USDA 2013).

Potential strategies include:

Producers' management systems modifications: Adaptation to heat stress are dictated by size of the farm and operation. Small farms can invest in traditional strategies such as early stocking, frequency of litter change and the raising local genotypes. Raising of naked neck chicken has increased by small and medium scale farmers due to their ability to dissipate heat (Fathi et al. 2013). Medium and large farms adopt modern technologies such as air and water ventilation, the use of low-energy bulbs which emit less heat. Giving medicines and vitamins for the birds, litter spreading and de-caking of the chicken houses are also useful (Liverpool-Tasie et al. 2019). Integrated poultry-fish farming, pasture-based poultry production systems, semi range housing

for chicken and integrated poultry manure management for crop and dairy production are also practiced by Kenyan farmers. There is a shift of keeping indigenous to improved indigenous chicken lines.

Breeding strategies: KALRO and Egerton University have been involved in developing climate smart chicken breeds and improving indigenous chicken productivity, respectively (Ilatsia et al. 2017). The chicken have better performance and are now sold to farmers for commercial production.

Institutional and policy changes: The State Department for Livestock is the lead organ propelling poultry production in collaboration with other state agencies. Under the Big Four Agenda, the department is building hatcheries for multiplication of adapted chicken breeds in Taraka Nithi and Baringo counties, and building modern slaughterhouses (Chwele, Bungoma county) to provide market access to poultry producers.[3] These initiatives will help increase producers engage in poultry as a diversification strategy and provide more climate resilient food and income sources. The removal of taxes by the East African Community on raw material for the manufacture of animal feeds has encouraged private investment in the East African feed industry and increased the variety of feeds available and competition that could result in high quality products that increase production efficiency.

Changing farmers' perception and adaptive capacity: Farmers who have experienced heat related losses are more likely to adopt modern practices and more likely to adopt multiple adaptation strategies at a time (Liverpool-Tasie et al. 2019).

Despite the negative impacts of climate risks, chicken production is an important part of rural households' adaptation portfolio. In instances where there is delayed onset of rain, increased chicken production has helped to diversify food and generate income to help women's poultry groups cope with climate shocks in Embu, Kajiado and Narok (Walsh 2019, Business Daily 2018, UNDP n.d.). Therefore, poultry production can be promoted for its adaptation benefits for rural households.

There is a need to better understand the link between different poultry management practices and key meteorological variables. No comprehensive study on poultry adaptation options to climate change has been conducted in Kenya. A systematic assessment of climate risks and adaptation options covering the entire poultry value chain should be conducted.

5.4 GHG mitigation

5.4.1 GHG emissions

Poultry make a relatively small contribution to Kenya's total GHG emissions. In poultry production, feed production is the main source of emissions but manure emissions are also significant, especially in laying and backyard systems (FAO 2013). FAO estimates suggest that the average emission intensity of chicken is 5.4 kg CO_2e/kg CW for meat and 3.7 kg CO_2e/kg for eggs. Therefore, the estimated GHG from poultry in Kenya using 2019 output can be estimated to be 3,342

[3] Personal communication, Head of poultry section, SDL.

Gg CO_2e and 483 Gg CO_2e for eggs and meat respectively. This includes emissions from feed production, which occur in the agriculture and energy sectors. Note also that:

- Emissions from direct energy use (i.e. on-farm heating, ventilation, but excluding feed production) are significantly higher for meat (4.5 MJ/kg CW) than for eggs (1.3 MJ/kg egg).
- Manure N_2O emissions are much higher for backyard chickens compared to commercial chickens.

Overall the total feed emission intensity per kg of CW or eggs (not including land use change) for backyard meat and eggs is similar to that of layers and broilers. This data is from FAO global assessments. No specific assessment has been conducted in Kenya.

5.4.2 Mitigation options

There has been no specific assessment of mitigation options in Kenya's poultry sector. General measures proposed in KCCRS include appropriate use of biotechnologies which increase food production per unit area while simultaneously limiting GHG emissions; proper management of agricultural waste (e.g. using manure to produce biogas); and promotion of agroforestry especially tree-based intercropping. These measures can be customized to the poultry sub-sector. These measures are in line with the Kenya Climate Smart Agriculture Strategy to meet food security objectives with GHG mitigation as a co-benefit (KCSAS 2016).

Specific mitigation options in poultry to explore include:

Animal breeding:

• **Selecting more productive poultry that enhance productivity and thereby lower GHG emission intensities.** This has been achieved through within-breed selection and cross-breeding programs (Gikunju et al. 2018). Cross breeding programs can deliver simultaneous adaption, food security and mitigation benefits. In general, as animals become more productive, greater feed intake is needed to support the energy requirements associated with performance, but the proportion of total energy requirements required for maintenance decreases. Thus, the feed input per unit of product produced is reduced. Further, with increases in productivity, fewer animals are needed to reach a given level of output (Wall et al. 2010). This increase total output of poultry so that total animal source protein demand is met with lower GHG impact.

• **Improved fertility**: Improving fertility would lead to decreased numbers of replacements required, with a consequent significant decrease in GHG emissions.

• **Improving feed conversion efficiency**: Poultry produce relatively small amounts of enteric CH_4, but their manure can be a significant source of GHG production. Therefore, maintaining or improving feed conversion efficiency and subsequently reducing the volume of manure produced for a given level of output, is considered a major strategy for mitigating CH_4 and N_2O (Hristov et al. 2013).

Improved and alternative feeding practices: Feed production contributes about 57% of emissions from both chicken and egg supply chains, with an additional 21.1% related to the expansion of soybean cultivation in the case of meat and 12.7% in the case of eggs (Gerber et al. 2013a). Current efforts to replace and substitute soybean meal with insect derived protein sources (e.g. Black solder fly larvae (Nyakeri et al. 2017, Onsongo et al. 2018) and grasshoppers)

and with *Prosopis juliflora* pods (Khobondo et al. 2019) can mitigate the GHG emissions and help in waste management.

• **Waste management**: Anaerobic biodigesters can be used to capture biogas, which can be flared, used to heat poultry brooders or generate electricity. This can be applied to large scale commercial poultry producers. Manure emissions account for 20% of emissions in eggs and 6% in broilers. Renewable energy sources (e.g. solar and wind energy) can be used to provide power for operation in commercial poultry houses, hatcheries etc.

More generally, increasing the proportion of animal source protein supplied by the poultry sector can decrease the overall GHG footprint of the livestock sector. This is because poultry meat and egg production are the most efficient animal protein production systems and has the smallest carbon footprint per unit product produced. Poultry are more environmentally efficient because of the low overheads of poultry breeding stock (much greater fecundity of hens; 250 progeny per hen each year versus one calf per cow); efficient feed conversion; high daily weight gain of poultry (made possible by genetic selection and improved dietary formulation).

There are still many uncertainties and knowledge gaps regarding mitigation options and their potential effects in the poultry sector. There is very little documentation and assessment for Kenya, so both industry and consumers' awareness are relatively low, and specific interventions that national and county governments can make to reduce poultry GHG emissions have not been identified. However, it is important to note that there is some overlap between adaptation and mitigation options.

5.5 Up-scaling climate smartness in the poultry sub-sector

Table 14 lists selected past and present projects to promote poultry productivity. Projects to increase productivity, genetic improvement and address poverty and unemployment include 'Njaa Marufuku Kenya', National Agriculture Sector Development Project, Kenya Agricultural Productivity Project, and Smallholder Poultry Commercialization Development Project, among others. The indigenous chicken (IC) genetic improvement effort included the National Poultry Development Programme (NPDP) and smallholder indigenous chicken improvement programme (InCIP) initiated in 1974 and 2007, respectively (Ilatsia et al. 2017), and others.

Table 14. Selected poultry productivity projects in Kenya

1.	Avian Influenza Preparedness National Task Force (GoK, USAID, FAO, DfID)
2.	National Agricultural Extension Programme (NALEP) (SIDA).
3.	Early Detection, Prevention and Control of Avian Influenza in Kenya (DfID)
4.	Strengthening of Agricultural Training Centers (ATCs) (GoK).
5.	National Poultry Development Programme (NPDP) (Netherlands).
6.	Agricultural Sector Programme Support (ASPS) (DANIDA)
7.	NGOs, e.g. World Vision International, CARE International and Oxfam, Lutheran World Relief.
8.	Agricultural Productivity Project
9.	Smallholder Poultry Agribusiness Development Program.

In addition to those listed in Table 14, the Kenya Climate Smart Agriculture Project (KCSAP) has prioritized the chicken value chain in 20 out of the project's 21 target counties, and the NARIGP has also prioritized the chicken value chain in 19 out of 21 target counties. Both projects implement entire chicken value chain approach through technical and financial support to CIGs, MVG and Producer organizations (cooperatives associations), and KCSAP has a focus on promoting climate smart technologies. KALRO has produced a list of climate-smart chicken practices for KCSAP (Mwangi et al. 2019).

Several counties have developed strategies to upscale poultry production thereby creating jobs. Kirinyaga and Makueni counties have a "Wezesha Kirinyaga' economic stimulus program and MOBIGrow programs. The Wezesha Program is a collaboration of the County Government of Kirinyaga and The World Bank through the NARIGP. The poultry project will produce one million eggs per month that will translate to around KSh 10 million for the farmers. The program intends to build poultry houses, build poultry feed mill at Kiaga and donate 1200 layers. The program targets 32 community interest groups composed of 1,110 households. The eggs will be sold through Kirinyaga Investment Development Authority (KIDA), the County organ responsible for promoting and marketing of the county's investments. KIDA has sourced for markets in public and private institutions and businesses (Mwangi 2020).

Beyond government, several players offer technical advisory services and financial support to poultry chain value chain:

Extension services and technical information: Breeding companies, NGOs and agrovets offer extension services at a fee or when farmers have bought goods.
IT services: There is a KuKu Bora platform that offers information on production, marketing and technical services.
Business development services: There are business development services providers that include CREADIS, ACK, GIZ, SDCP, ACTION AID, Technoserve, Oxfam etc
Research: KALRO, ILRI and universities offer climate smart innovations. Example are KALRO climate smart chicken breed lines, alternative feed ingredients like use of Black soldierfly as an alternative to fish meal and soy meal.
Financial institutes: Some banks offer financial services to commercial poultry producers. Kenya Commercial Bank through '*MobiGrow from chick to market poultry empowerment project'* launched a KShs. 300 million poultry farmer empowerment project in Makueni. The project ought to see over 1000 poultry farmers in Kibwezi benefit from credit facilities, capital, vaccinated insured chicks, chicken feed and vaccines (UPESI News 2019).

5.6 Policy alignment and implementation

Poultry development is aligned with Anchors 1 (increase small-scale farmers' incomes) and 2 (increase agricultural output and value added) of the Agricultural Sector Transformation and growth Strategy 2019-2029 (ASTGS). The sector is also represented in the NAIP flagships 1 and 2.

Although KCSAIF does not single out poultry, thematic area 2 (mitigation of greenhouse gas emissions) and thematic area 3 (enabling policy legal and institutional framework) can be supported to upscale poultry climate smart technologies. Development of the poultry sub-sector

and upscaling of adaptation and mitigation options is therefore in line with national agricultural and climate change policy frameworks.

The main recommendations for near-term actions the poultry sub-sector to further implementation of the existing frameworks are:

- Conduct a systematic assessment of adaptation and mitigation options in the poultry sub-sector;
- Engage with existing projects, county governments and stakeholders to understand barriers to upscaling proven adaptation and mitigation options and ways to overcome them; and
- Identify measures that national government can take to support county governments and other stakeholders to upscale adaptation and mitigation practices in the poultry sector.

6 STRENGTHENING NDC IMPLEMENTATION IN THE LIVESTOCK SUB-SECTOR

This chapter examines the policy and institutional framework for climate smart livestock in Kenya. It highlights prominent challenges and proposes near-term actions that SDL can take to progress implementation of Kenya's NDC in the livestock sector.

6.1 Policy Framework Overview

Kenya has a clear national policy framework to guide climate change action in the livestock sector. The guiding documents in the climate change domain are the First Nationally Determined Contribution (NDC), the National Climate Change Action Plan (NCCAP) and the National Adaptation Plan (NAP).

The First NDC states that in the agriculture sector, priority actions for mitigation are Climate Smart Agriculture (CSA) measures "in line with the national CSA framework" and the priority agricultural adaptation action is to "enhance the resilience of the agriculture, livestock and fisheries value chains by promoting climate smart agriculture and livestock development". Thus, both mitigation and adaptation objectives for agriculture in the NDC prioritize CSA.

The NCCAP also states the objective to "Increase food and nutrition security through enhanced productivity and resilience of the agricultural systems, in as low-carbon a manner as possible", and prioritizes adaptation actions for food and nutrition security over the mitigation of GHG emissions. Implementation of Kenya Climate Smart Agriculture Strategy (KCSAS) is the main priority action in the agriculture sector.

The national framework for CSA is given by the Kenya CSA Implementation Framework (KCSAIF), which follows from the KCSAS. The KCSAIF includes the objective "to reduce vulnerability of agriculture systems by cushioning them against the impacts of climate change and reduce GHG emissions where possible". All components of KCSAIF list adaptation actions relevant to the livestock sector. Some of these actions may also have mitigation co-benefits (Text Box 3). The dairy

NAMA is the only prioritized action for mitigation in the livestock sector in the NCCAP MTAR, because dairy is the only sub-sector for which options have been systematically assessed. The livestock sub-sector adaptation actions listed in the NCCAP ATAR focus on the more vulnerable pastoralist systems in the ASAL regions.

Text Box 3: Adaptation and mitigation synergies in KCSAIF

KCSAIF Component 3 ('Building resilience and appropriate mitigation actions') includes a sub-objective "to promote adaptation interventions and appropriate mitigation that leads to reduced GHG emissions intensity from the agriculture sector without compromising productivity". Relevant actions include promoting efficiency in livestock production systems, developing and implementing Nationally Appropriate Mitigation Actions, and promoting adaptation actions with mitigation co-benefits. Other actions in KCSAIF that are noted as relevant to mitigation include promoting low-emission technologies in livestock value chains (Sub-component 2.1) and sustainable land and grazing management practices (Sub-component 3.1).

The NAP also highlights that promoting CSA is the long-term priority action. In the short- and medium-term various specific CSA measures are listed, alongside generic actions to raise awareness and provide information on CSA, and to coordinate, mainstream and develop measurement frameworks for the sector.

All activities to be implemented for the KCSAIF are to be coordinated by the National and County Ministries/Departments of Agriculture and CCUs who will be reporting through the Joint Agriculture Sector Steering Committee (JASSCOM). It is worth highlighting that KCSAIF Component 1 focuses on institutional coordination as the basis for creating an enabling environment for CSA promotion. Sub-components include inter-ministerial and county government coordination; partnerships with civil society and the private sector; coordination with development partners; monitoring and evaluation (M&E) of CSA; and strengthening institutional capacities. Some counties do not yet have a climate change unit, and in some counties this unit is not under the ministry of agriculture, which can create challenges for implementing CSA. Communication lines between the Climate Change Unit of Ministry of Agriculture, Livestock and Fisheries at national level and counties needs to be strengthened.

The overall thrust of climate change policies is well aligned with national priorities in the Agriculture Sector Growth and Transformation Plan (AGSTS) and National Agriculture Investment Plan (NAIP). AGSTS and NAIP prioritize development of poultry, beef and dairy sub-sectors. Less priority is given to small ruminants (sheep and goats). The NAIP notes that sheep and goats are relevant for some specific counties, but sub-sector analysis suggests that small ruminants are worthy of more attention in the context of climate change. Analysis of livestock sub-sectors also suggests that gender issues should be central to CSA promotion, which is also noted in the NAIP.

6.2 Overview of ongoing initiatives

KCSAIF provides the key framework that integrates Kenya's various climate change policies, implementation of KCSAIF is a priority in the forthcoming NDC period. KCSAIF Component 1 aims to strengthen the enabling environment for CSA promotion. Sub-components include inter-ministerial and county government coordination; partnerships with civil society and the private sector; coordination with development partners; M&E of CSA; and strengthening institutional capacities.

Inter-ministerial and county government coordination: KCSAIF is to be implemented through the Joint Consultation and Cooperation Mechanism for the Agricultural Sector. The Intergovernmental Forum on Agriculture, JASSCOM and Joint Agriculture Sector Technical Working Groups are the main institutions for governmental coordination. The Council for Exceptional Children caucus and council of agriculture and convened by the council of agriculture committee through the JASSCOM or other systems within the Council of Governors.

Partnerships with civil society and the private sector: SDL is an active participant in the CSA MSP. So far, the MSP has held 3 meetings, attended by a broad range of government and non-government stakeholders, including NGOs, the private sector and researchers. With support from FAO and UNDP a common CSA M&E Framework is being drafted. The MSP is one forum for consultation and obtaining feedback on the draft document. During development of the Dairy NAMA, SDL convened three meetings of a Dairy NAMA MSP, but no meetings have occurred since the concept note was approved. SDL frequently participates in other multi-stakeholder forums in both the agriculture and climate change arenas. The sub-sector briefs highlighted that upscaling adaptation and mitigation actions in the livestock sector requires participation of stakeholders from various sectors, including finance and industry. CSA MSPs and other MCP will play key roles in continued upscaling of CSA. Currently, the CSA MSP is national. Many businesses and NGOs work with county governments, so a future innovation might be to convene CSA MSPs for regional groupings of counties to enable more stakeholders working at local levels to participate.

M&E of CSA: With support from FAO and UNDP, a KCSAIF M&E Framework is currently being drafted to elaborate and operationalize the KCSAIF Results-based Logframe. The M&E Framework includes the objectives to achieve a coordinated, coherent and cooperative governance of CSA and to mainstream CSA in the agricultural sector. The framework aims to ensure that the implementation of the KCSAIF is efficient and stakeholders are able to track progress of KCSAIF-related initiatives. The framework will also be used as a learning tool, including through mid-term and final reviews, which may be important opportunities to review and update related policies and measures. The draft framework tracks indicators related to each KCSAIF Component. For livestock-specific indicators of CSA adoption, national and county livestock sector reports are specified as the data source and generic reporting formats are given. Data sources are likely to be from various sources, such as project- or region-specific reports by various institutions. In the draft framework, state departments have the responsibilities shown in Text Box 4.

Text Box 4: Roles and responsibilities of State Departments in the draft KCSAIF M&E Framework

• Set departmental specific targets for climate change
• Develop strategies to achieve the targets
• Coordinate CSA M&E at the departmental level
• Develop departmental indicators and baselines
• Compile and submit CSA M&E reports to CCU of the Ministry for analysis and forwarding to Climate Change Directorate

To operationalize the framework in the livestock sector, it will be necessary to

- Further specify sub-indicators, and possibly specify additional indicators relevant to priorities of interest to livestock sector stakeholders that are not reflected in the overall framework;
- Align sub-sector CSA M&E with M&E of the NCCAP and NAP and other livestock sub-sector reporting requirements, recognizing at the same time that some of these M&E frameworks, as well as CIMES, are in the early stages of development;
- Set baseline and target values based on SDL and stakeholders' plans in the sector;
- Develop practical procedures for data collection, management and information sharing;
- Allocate responsibilities within SDL and among stakeholders and, where necessary, build the required capacities to implement CSA M&E in the livestock sector.

SDL has also taken on responsibility for compiling the Tier 2 inventory for dairy GHG emissions. This needs to be compiled and submitted on at least a biannual basis. The Climate Change Directorate is developing MRV systems, including a National Climate Change Registry of mitigation, adaptation and enabling actions as directed under Section 9(8) of the Climate Change Act (2016). The required content of the registry and how it will operate are not known at present.

CSA implementation in the livestock sub-sector: The preceding chapters on each sub-sector show that many key adaptation and mitigation measures are already being promoted by government and other stakeholders in the sector. At present, there is no systematic inventory of these initiatives. Although many organizations may be known to ministry staff, there is little flow of specific information about what each initiative is doing. For many adaptation and mitigation options, barriers to upscaling and ways to overcome them have not been assessed in detail. The experience of the Dairy NAMA shows that when initiatives for upscaling have been assessed in detail, they are more likely to gain traction at policy level, but getting the initiatives financed requires that upscaling initiatives are developed in close collaboration with development partners and other stakeholders in the sector.

6.3 Key Challenges

KCSAIF provides the framework for implementing Kenya's NDC in the livestock sector. KCSAIF provides a comprehensive framework for promoting adaptation and mitigation in the livestock

sector. Implementing KCSAIF will require that the framework is translated into the specifics appropriate to each sub-sector. There are clear linkages with other policies in the agriculture sector, ASAL regions and climate change sector. The main challenge for SDL is how to define and strengthen its role in implementing KCSAIF in the livestock sector. SDL has a broad mandate (Text Box 5), with specific functions as defined in the Kenya National Livestock Policy, which are implemented in coordination with various semi-autonomous governmental agencies.

Text Box 5: Functions of SDL

- Livestock policy management
- Development of livestock industry
- Veterinary services and disease control
- Range development and management
- Livestock marketing
- Promotion of dairy industry
- Livestock insurance policy
- Livestock branding
- Promotion of bee keeping
- Promotion of tannery industry

Four key challenges are:

1) Identifying adaptation options and mitigation co-benefits with upscaling potential and the measures required to overcome barriers to upscaling;
2) Aligning SDL support to CSA implementation with the large number of ongoing initiatives in the livestock sector;
3) Coordination and information exchange with county governments;
4) Developing systems to perform SDL's roles in CSA M&E and national MRV.

Financing and capacity building remain longer-term challenges. In the current stage, determining the priority focuses for SDL's support can help determine what finance is required and target capacity building activities to stakeholders' specific needs related to key adaptation and mitigation strategies.

6.4 Options to address key challenges

NDCs can be enhanced on the basis of a stock-taking of trends, policies and measures, and actions of sub-national and non-state actors in the sector; by updating assumptions and analysis; by ensuring alignment of the NDC with sector development objectives; by ensuring complete coverage of sectors and sub-sectors; and by ensuring that adaptation priorities, policies and plans are appropriately reflected.

Based on the situation analysis presented above, two main areas of action are outlined for SDL to consider in order to support CSA implementation in line with KCSAIF priorities in the livestock sub-sector. The action areas are summarized in Text Box 6, and four potential specific actions are outlined in the text that follows.

Text Box 6: Proposed Action areas for SDL

Action area 1: Stock-taking and development of a livestock sub-sector climate change action plan. This action area addresses the challenges of identifying adaptation options with upscaling potential; aligning SDL support with ongoing initiatives; and coordination with counties. The purpose of developing a climate change action plan for the livestock sub-sector is to support coordination in the sub-sector and to assist in resource mobilization for enhanced climate action. A sub-sector climate change action plan can also provide clear guidance for actions within the functional mandate of SDL and other semi-autonomous government agencies to support promotion of CSA implementation in the livestock sub-sector. The recommended process involves assessing and identifying adaptation and mitigation actions for upscaling. This will also inform adaptation and mitigation targets in the third NDC.

Action area 2: Monitoring and evaluation, reporting and MRV. The purpose of this action area is to develop the systems, procedures and capacities required for SDL to be able to collaborate with sub-sector stakeholders in monitoring and evaluating progress in promoting and implementing CSA in the livestock sub-sector, and to develop capacities for MRV of GHG emissions and emission reductions in the livestock sub-sector. This will support sector coordination and enable tracking of government and non-government actions to support stakeholder learning and UNFCCC reporting.

(1) In-depth assessment and identification of adaptation and mitigation options. *This will contribute to identification of feasible livestock sub-sector climate actions for inclusion in the third NDC.*

- Documentation of vulnerability to climate change and extreme events by livestock in different production systems and in grasslands, for evidenced based development of policies and measures in the livestock sub-sector.
- In-depth feasibility assessment in each production system for each livestock species for upscaled implementation of key adaptation and mitigation strategies.
- Inventory of domestic (national and county government, non-government, private sector) and internationally-supported initiatives that promote key adaptation and mitigation strategies.
- Stakeholder-led identification of adaptation and mitigation initiatives for upscaling.

(2) Develop a Livestock Sub-Sector Climate Change Action Plan. *This will support coordination in the sub-sector and assist in resource mobilization for enhanced climate action.*

- Engage stakeholders and key supporting institutions in the main initiatives in each production system for each species to identify actions to support upscaled implementation of key adaptation and mitigation actions in the livestock sub-sector and ensure coordination with stakeholders.
- Develop strategies for the national government to promote CSA in the livestock sub-sector, including:
  - strategies to ensure that these actions are mainstreamed in the workplans of SDL divisions and units and related semi-autonomous government agencies;
  - strategies to ensure that these actions are mainstreamed in the work of other relevant MDAs and county governments;
  - strategies to support non-government and private sector actors to address sector support needs;

- coordination mechanisms to engage the key stakeholders in each strategy.

(3) Improve monitoring and evaluation of livestock sub-sector climate actions. *This will support sector coordination, enable tracking of non-state climate actions and support UNFCCC reporting*

- Design livestock CSA M&E system to provide and track information on:
  - Progress in implementing Livestock Sub-sector Climate Change Action Plan;
  - KCSAIF M&E framework indicators;
  - Information required by sub-sector stakeholders;
  - Other indicators as required by national MRV systems (e.g. adaptation and mitigation action registry).

(4) Improve MRV of livestock GHG emissions. *This will improve national capacities for MRV to support implementation and tracking of climate actions.*

- GHG inventory compilation:
  - Continue to compile and submit the Tier 2 dairy cattle GHG inventory on an annual basis;
  - Expand application of Tier 2 method to the other livestock species;
  - Continue to build SDL capacity for GHG inventory compilation.
- GHG inventory improvement:
  - Collaborate with national and county stakeholders to improve livestock administrative statistics in line with GHG inventory data needs;
  - Strengthen county capacities for improved livestock data collection.
- MRV system improvement:
  - Revise NDC GHG BAU projections for livestock GHG emissions based on Tier 2 emission factors and revised livestock population time series in view of the 2019 livestock census results;
  - Develop models for tracking change in emission intensity of livestock production in line with key adaptation and mitigation strategies.

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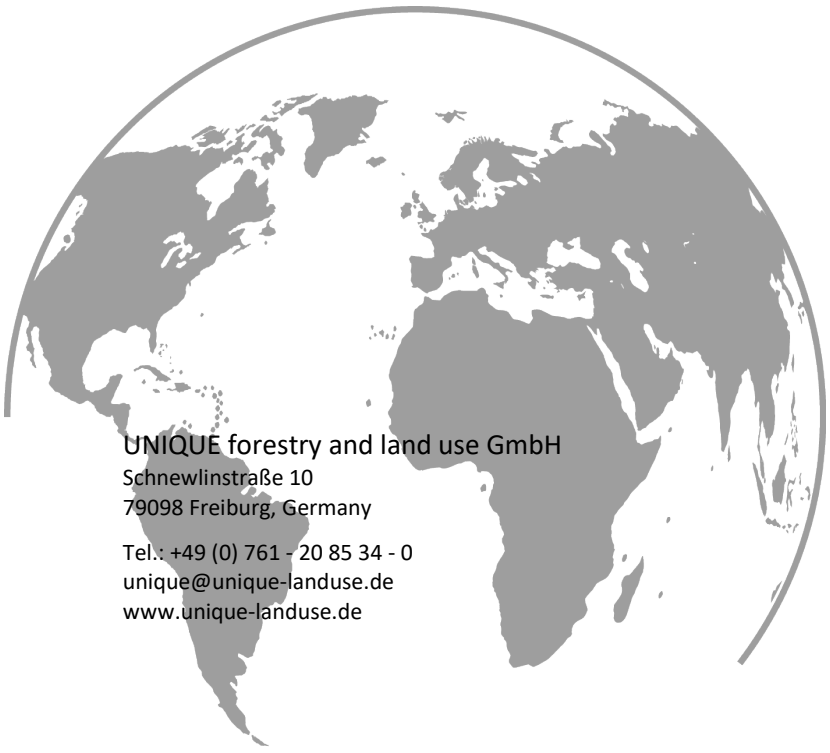

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