Highlights from the CSDEK programme 2018–2020

Climate-Smart and Inclusive Dairy Business Models

in Ethiopia and Kenya

Climate-smart dairy

Business uptake

Inclusive dairy

Scaling and impact

NFP Netherlands Food Partnership

van hall larenstein university of applied sciences

Contents

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Preface

This magazine presents the highlights of the applied research project "Inclusive and climate-smart business models in Ethiopian and Kenyan dairy value chains (CSDEK)". CSDEK ran from 2018 to 2020 and was made possible with financial support from the Dutch Research Council (NWO) of the Government of the Netherlands, and the Climate Change Agriculture and Food Security (CCAFS) programme of CGIAR. Project partners were Van Hall Larenstein University of Applied Sciences (VHL, lead partner, the Netherlands), Jimma University (Ethiopia), United States International University – Africa (Kenya), Michigan State University (USA), AgriProFocus (now Netherlands Food Partnership) and UNIQUE Forestry and Land Use GmbH (Germany). NWO collaborated with CCAFS through its Global Challenges Programme, and UNIQUE represented CCAFS. The contents of this magazine are the responsibility of the implementing organisations and do not necessarily reflect the opinion of NWO or CCAFS.

The CSDEK applied research project was conducted in six case study areas, three in Ethiopia and three in Kenya. At the time of publishing this magazine, research was still ongoing in some of the study areas. The project team and researchers hope to contribute to creating awareness of climate-smart dairy practices and development of the dairy sector in Ethiopia and Kenya. In two of the study areas, collaboration between VHL and dairy stakeholders will continue, preferably through local networks in a Living Lab approach.

I would like to express my appreciation to all project staff, students and network partners involved in this research and knowledge sharing. Happy reading!

Dr Robert Baars (Project leader CSDEK)
Professor Climate-Smart Dairy Value Chains
Van Hall Larenstein University of Applied Sciences

Teff straw is an important fodder for dairy cows in Ethiopia

Introducing the CSDEK programme

The dairy milksheds in the highlands of Ethiopia and Kenya are mostly smallholder farms and predominantly use informal marketing. The dairy sector is characterised by low productivity, land scarcity, limited chilling options in rural areas and processors that are working below capacity. All this results in high greenhouse gas (GHG) emissions and low climate resilience.

Higher efficiency in the dairy chain will improve production, reduce losses and subsequently contribute to farmers' income and the climate-smart agenda. Dairy development efforts should be inclusive for smallholders, women and youth to ensure that economic and resilience benefits are widely shared.

The growth of the dairy sector and the emergence of formal dairy chains offer opportunities in both countries for climate-smart dairy practices that increase efficiency and reduce losses. In this context, the "Inclusive and climate-smart business models in Ethiopian and Kenyan dairy value chains" programme was developed by Van Hall Larenstein University of Applied Sciences (VHL) and its partners.

Research questions

1

What business models exist in the dairy value chain that are suitable for scaling up?

a. How do these business models contribute to inclusiveness, resilience and climate-smart outcomes?

b. What are the key barriers to and triggers for scaling up effective business models?

c. What is needed to support inclusive and climate-smart dairy value chain development?

2

What climate-smart strategies exist to optimise market-oriented dairy value chain development?

a. What are the successes and failures in the transformation towards market orientation for men and women?

b. What are the required roles and responsibilities of different private and public organisations in climate-smart market orientation?

c. What are the required organisational and institutional capacities of male and female actors and supporters in dairy value chains?

CSDEK applied research

The objective of this research was to identify scalable, climate-smart dairy business models in the context of the ongoing transformation from informal to formal dairy chains in Kenya and Ethiopia.

The programme was funded under the Global Challenges Programmes round 4 (GCP-4) from NWO-WOTRO, which had a focus on climate-smart agriculture. In the period 2018 to 2020, 20 students, mostly mid-career and MSc level, from the participating universities did their fieldwork and theses within the scope of the CSDEK programme. In addition, three PhD candidates from VHL in the Netherlands, Moi University in Kenya and Jimma University in Ethiopia are deepening the overall analysis of these milksheds and identifying the pathways for scaling up climate-smart and inclusive dairy.

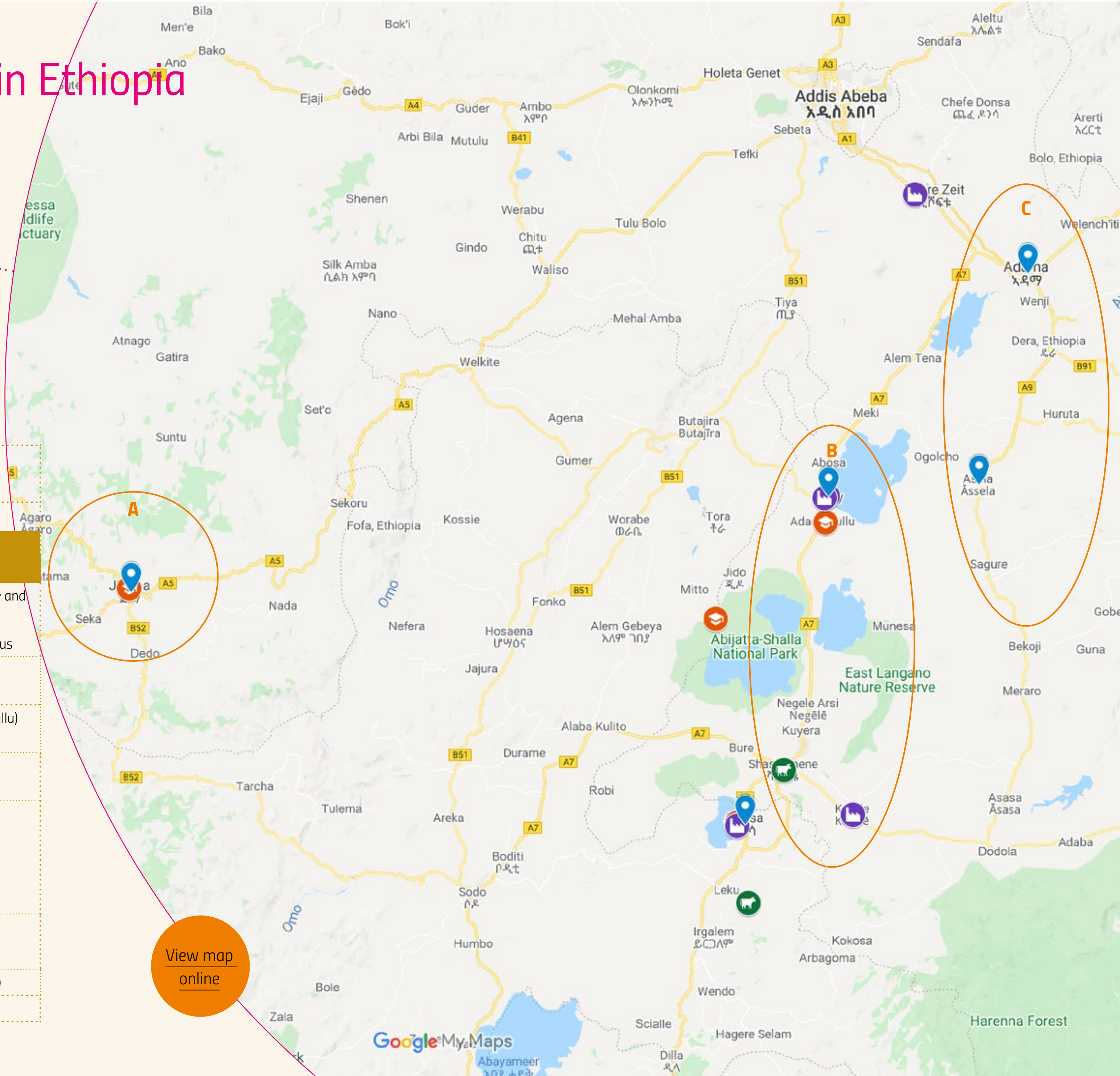
Together with the insights from UNIQUE Forestry and Land Use GmbH (Germany), an understanding is emerging of the climate-smart and inclusive business models for input suppliers, farmers, coops and processors. These models include actors' own perspectives and expectations from other stake-holders.

Map of three milksheds in Ethiopia

PhD research area Eyerus Muleta	**A** Jimma milkshed **C** Adama-Assela milkshed
PhD research area Marco Verschuur	**B** Ziway-Hawassa milkshed

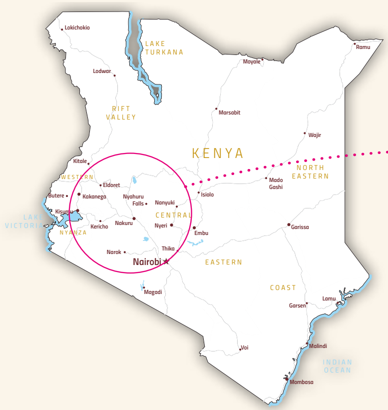
Actors in milkshed B Ziway-Hawassa

Symbol	Category	Name and location
	University	Jimma University College of Agriculture and Veterinary Medicine Hawassa University Agricultural Campus
	Vocational Education	Agricultural Technical College (Alage)
	Research centre	Agricultural Research Centre (Adami Tullu)
	Feed Plant	Alema Koudijs (Debre Zeit - Bishoftu)
	Processors	Holland Dairy (Debre Zeit - Bishoftu) Almi (Hawassa) Yaya (Ziway) Gobe Farm (Kofele)
	Cooperatives	Biftu Dairy Coop (Shashemene) Shebedino Dairy Coop (Shebedino)
	Dairy farms	4,463 mixed farms (2013, estimation)
	Milk yield / year	9,645,000 liters (2013, estimation)



View map online

Map of three milksheds in Kenya



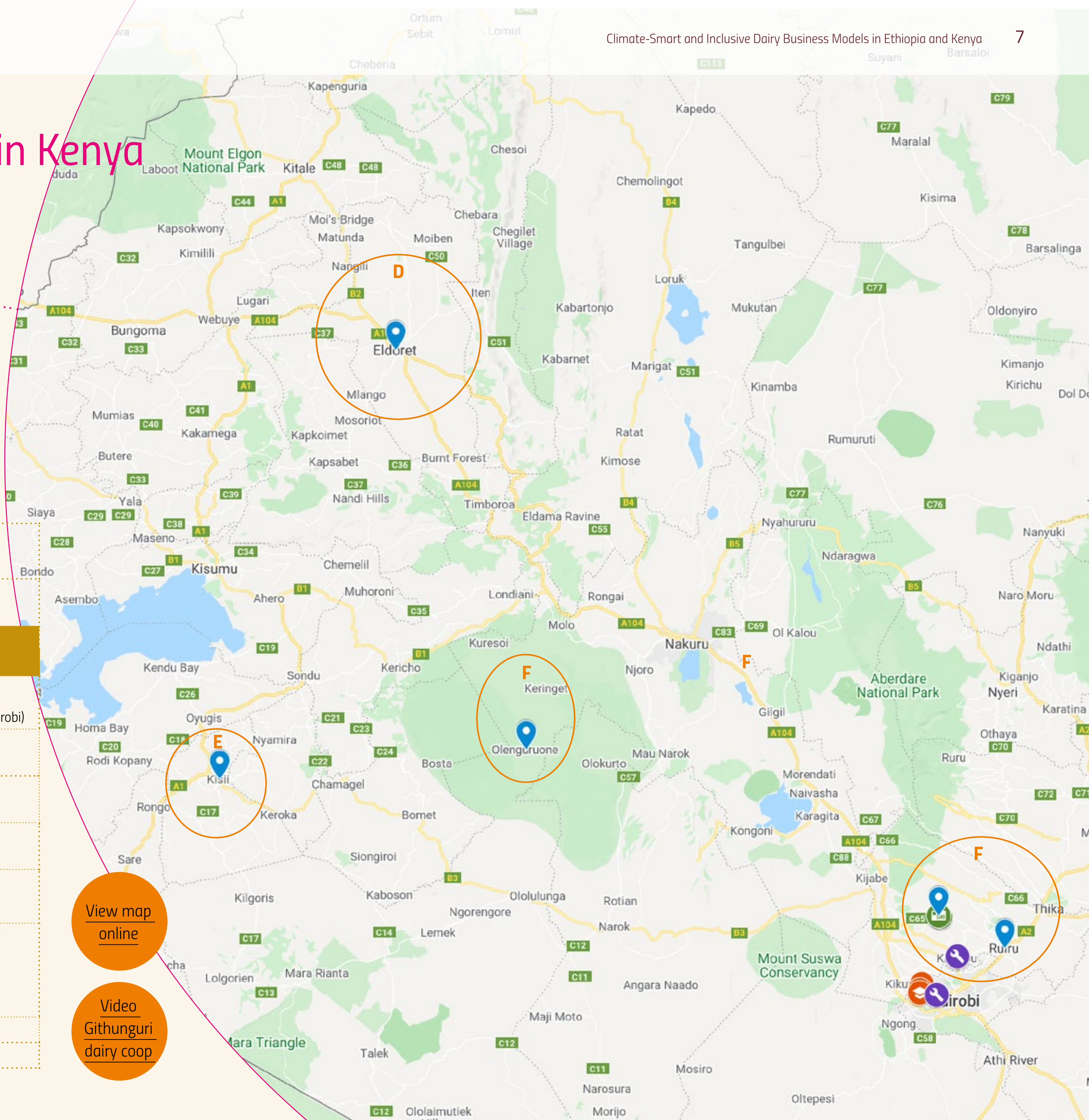
PhD research area Francis O. Oduor	**D** Uasin Gishu - Eldoret milkshed **E** Kisii milkshed
PhD research area Marco Verschuur	**F** Kiambu-Githunguri milkshed (including Nakuru-Olenguruone)

Actors in milkshed F Kiambu - Githunguri

Symbol	Category	Name and location
	University	University of Nairobi (Kabete) Wangari Maathai Institute (Univ of Nairobi)
	Vocational Education	Animal Health and Industry Training (AHITI, Kabete)
	Research centre	CCAFS (at ILRI, Kabete)
	Processors	Fresha milk plant (Githunguri)
	Service Provider	Keilot Off-Grid Energy Ltd (Nairobi) Warahiu agri training centre (Kiambu)
	Cooperatives	Githunguri Dairy Farmers Coop Society (GDFCS) GDC Savings and Credit Cooperative (Githunguri)
	Dairy farms	13,500 active members in GDFCS
	Milk yield / year	85,320,604 kg (Kiambu county)

View map online

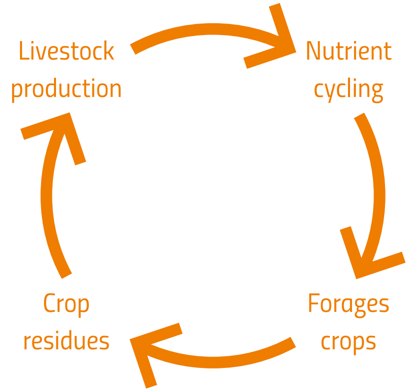
Video Githunguri dairy coop

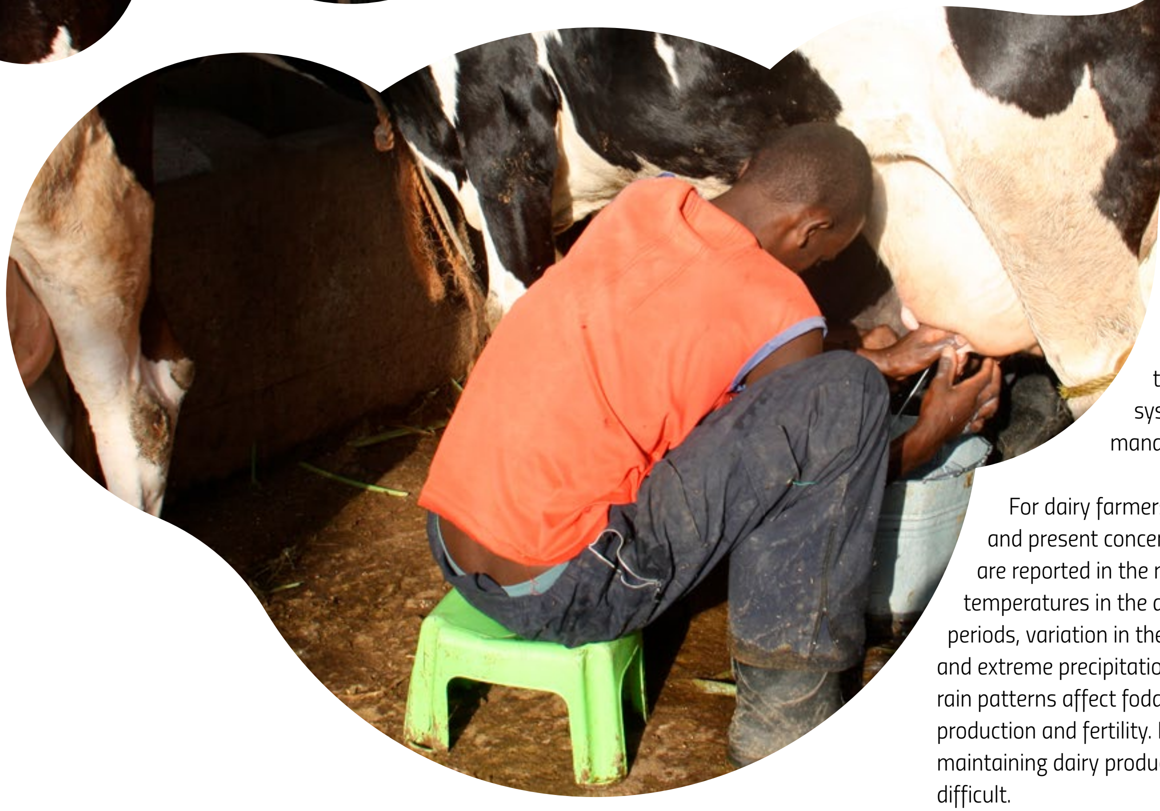


African alumni of Dutch dairy courses met to discuss sustainable dairy development in East-Africa

Climate-smart dairy

Ethiopia and Kenya both have national climate action plans with specific targets for dairy. Kenya aims to reduce emissions from dairy by 400,000 metric tons of CO_2 equivalent by 2022. Measures to achieve this include efficiency in dairy management and adoption of biogas technology.





Ethiopia's Climate-Resilient Green Economy aims to limit GHG emissions to today's level of 150 million metric tons of CO_2 equivalent per year. One priority is improving livestock production through breeding, feeding systems and pasture/grazing management.

For dairy farmers, climate change is a real and present concern. Changes in climate that are reported in the milksheds include higher temperatures in the dry season, longer dry periods, variation in the start of the rainy season and extreme precipitation. The heat and irregular rain patterns affect fodder production, animal production and fertility. Especially in the dry months, maintaining dairy production is becoming more difficult.

The environmental impact of dairy is mostly due to ruminating cows that emit methane through belching and flatulence (enteric methane emission). Livestock manure and urine are also significant sources of methane and nitrous oxide when broken down under anaerobic conditions. Anaerobic conditions often occur where manure and urine are mixed or stored in large piles.

Feeding regimes influence the level of emissions. Transporting fodder from outside the region contributes to emissions and leads to local manure surpluses, while making compost or storing manure in dry conditions helps reduce emissions. Another measure that can be taken at farm level is using the manure to produce fodder.

In the next pages, four Van Hall Larenstein (VHL) dairy master students report on the climate-smart dairy practices found in the Ziway-Hawassa and Githunguri milksheds.

Climate-smart dairy practices in the Githunguri milkshed

Allen Kiiza mapped the climate-smart dairy practices of 48 dairy farmers in the Githunguri milkshed. Most keep improved breeds under zero-grazing and combine cropping with dairying. The farms vary in production levels, as some farmers buy additional feed for their cows and get more milk. A significant challenge for all dairy farmers is the decrease in fodder availability during the dry season, which results in lower milk output.

The climate-smart dairy practices identified by Allen are presented in the table. Some practices are climate-smart without farmers labelling them as such. Barriers to further adoption of climate-smart dairy practices are limited awareness of them, as well as insufficient funds to adopt these practices.

Mitigation measures	Practices identified	Adoption level (n=80 farmers)
Soil conservation	Crop rotation, mixed cropping, mulching, manure for crops	> 60%
	Agroforestry, terracing, contouring	< 30%
Fodder crops	Napier	> 60%
	Legume grasses, fodder trees	< 30%
Fodder conservation	Hay	30–60%
	Silage	< 30%
Feeding crop residues and by-products	Maize stovers, weeds, brewers waste	30–60%
Feeding concentrates	Dairy meal, bran, supplements	> 60%
Water harvesting	Electric pumps	> 60%
Zero grazing	Dairy cow sheds	> 60%
High yielding cows	Friesian breed, artificial insemination	> 60%
Manure management	Composting, biogas	< 30%
Low emission collection	Milk Collection Centre within walking distance	> 60%

Allen: *"Our survey among the dairy farmers was done in 2018 by a team of three students. We analysed the economics, the climate issues and inclusiveness of dairy. On climate, the farmers mentioned hotter weather, drought, cold seasons and inadequate rains. This means less feed and reduced milk yield. So farmers feed hay silage or alternatives like banana peelings and stems. Some decide to reduce the herd size.*

We discussed our findings in a workshop with farmers, the cooperative and other stakeholders. I am from Uganda, and our dairy farmers are facing the same types of problems. They also apply similar solutions.

Our first climate-smart advice for the farmers is to make better use of cow dung. If they cover the pile, they can reduce emissions and increase its value as organic manure. Many farmers already practice nutrient recycling: they feed crop residues to the cows and the manure is used to fertilise the crops. That integration is smarter than sourcing fodder from other areas. Our other advice is for the cooperative to include climate-smart dairy in their farmer trainings. Also, the coop can team up with government and other actors to promote awareness of climate-smart solutions."

Read more: Thesis of Allen Kiiza

Climate-smart practices in the fodder supply chain

In his fieldwork, **Honour Shumba** focused on the feed supply chain and the efficiency of dairy production in relation to emissions. There are huge differences between cows and the level of emissions. A key factor is the feed supply: dairy cows that get a balanced ration and sufficient volume of fodder have the lowest output of GHG per litre of milk.

The variation is also apparent between farms. Most farms cannot grow enough fodder for efficient milk production. Farmers rent additional land to grow fodder, reduce the fodder rations for their cows or buy additional fodder from transporters.

Honour: *"I was impressed with some of the farmers I interviewed in Githunguri. They had eight cows on 3–4 acres of land and still managed to produce at least 20 litres per cow per day. This was possible because they sourced fodder from Nakuru and Nanyuki. In comparison, the farmers in Ruiru were outside the fodder market. They had to conserve fodder, feed maize stover or let their cows graze on public lands; it's no surprise that their milk yield was lower.*

Our advice to the farmers is to adopt silage and haymaking, because it results in quality fodder for the cows and minimises CO_2 emissions from fodder transport. Consider using biogas to power the fodder choppers. There are different options for silage: Boma Rhodes grass, maize and Napier grass. I think maize is the better option because it can be grown in both seasons, and it is as nutritious as the other options. Another option is fodder from trees, but that requires trees other than eucalyptus. In any case, farmers should be trained how to grow fodder and cut it at the right time. They should value feeding quality over quantity.

The extension workers from the cooperative are mobile and motivated. Our advice is they start helping the farmers who are further away, who urgently need climate-smart training. Here extension can make a bigger difference than it would for urban dairy farmers."

Feeding strategy	Strength	Weakness	Climate smartness
Feed conservation (silage)	Ensures feed security in dry season	Expensive, requires labour	Steady productivity during dry season
Feeding crop residue (maize stover)	Very cheap	Limited availability	Low digestibility increases GHG emissions
Buying fodder (lucerne) from Githunguri Dairy Farmers Cooperative	Reliable quality	Expensive	Steady productivity during dry season
Buying fodder from traders	Unreliable quality	Expensive	Steady productivity during dry season
Buying concentrates	High digestibility	Expensive	Boosts productivity levels
Harvesting grass from public land	Very cheap	Risk of ticks and helminths	Poor quality hay increases GHG emissions
Grazing on forestry area	Affordable fees	Risk of mastitis, ticks and helminths	Feed intake not monitored

Read more: Thesis of Honour Shumba

Climate-smart dairy practices in the Ziway-Hawassa milkshed

Sara Endale and **Biruh Tesfahun** interviewed 80 urban and peri-urban dairy farmers in five districts in the Ziway-Hawassa milkshed. The interviews looked at the economics and gender division of tasks and the climate-smart practices in dairy. The interviews revealed that dairy was the primary activity of urban farmers, while peri-urban farmers combined dairy with crop production. The most remarkable conclusion is that urban dairy farmers have more productive cows and double the milk sales of their peri-urban peers.

Sara: *"Farmers usually associate climate change with unexpected high rainfall or an extended dry season with less rain and sudden high wind, which damages the crop.*

I think the impact of climate change is different for urban and peri-urban farmers. The urban ones have small plots with cross-breed animals and high productivity. Their strategy is to buy additional feed for their animals. They are vulnerable when the cost price of feed goes up.

The peri-urban farmers integrate dairy animals with crops. Their strategy is to produce for home consumption and sell the surplus. Their mixed system may be less productive, but it is also more resilient.

My recommendation for all farmers is to make money out of manure. Consider biogas, compost and replacing fertiliser in crops. The urban famers should continue their high input, high output strategy with quality feedstuffs and cross-breeds of dairy cows.

My advice for peri-urban farmers is to improve the integration of crops and animals. Within their mixed farm strategy, they should consider culling unproductive animals from the herd and managing the feed quality of crop residues."

Read more:
Thesis of Sara Endale

Thesis of Biruh Tesfahun

Feed resources	Feed costs		Farmer adoption	
	Urban (ETB/kg)	Peri-urban (ETB/kg)	Urban (n=51)	Peri-urban (n=29)
Green pasture	3.72	1.07	23.50%	31.00%
Maize green forage	2.84	0.96	25.50%	27.60%
Wheat straw	4.51	2.45	82.40%	72.40%
Barley straw	3.17	1.67	19.60%	48.30%
Teff straw	2.55	1.49	33.30%	17.20%
Almi dairy ration	8.60	9.00	51.00%	6.80%
Fagullo (linseed meal)	10.80	11.2	78.40%	48.30%
Frushka (wheat bran)	6.60	5.88	84.30%	69.00%
Cottonseed meal	11.34	8.34	2.00%	10.30%
Atella (local brewer's waste)	4.60	1.00	35.30%	3.40%
Brewers grains	1.43	2.10	15.70%	6.80%

Currency: ETB 10 = € 0.273 = KES 31.85

Greenhouse gas emissions during milk collection, cooling and processing

Godadaw Misganaw noted in the literature that 80% of GHG emissions in dairy happens at the farm. He focused his thesis on the other 20%, emissions that happen during raw milk collection, processing and distribution to retail and consumers. To estimate the carbon footprint, a survey was conducted of milk transporters at various milk collection points. Godadaw considered distance, quantity of milk, fuel and loading capacity used. For the emissions due to cooling at the collection centres, calculations based on electricity and fuel bills were used to estimate the energy used.

Four dairy processors in the milkshed turn approximately 1.8 million litres of milk into butter, yoghurt and cottage cheese each year. Almi Fresh company has a modern plant that uses electricity and a generator; the other three are small-scale processors that use fuel, electricity and, for cottage cheese, firewood as well.

Godadaw: *"In the Ziway-Hawassa milkshed, milk is mainly transported by minibuses and Bajaj; there is no chilled transport. The transporters perceive climate change too: they mentioned the rise in temperature, longer dry season and erratic rainfall with sometimes destructive flooding. It affects the roads and, as you know, fresh milk needs cooling within mere hours.*

In my research I first compared data from large and small collectors. The big ones use their loading capacity better. So I recommend that the small collectors work together like the small dairy farmers do. Together they can better use their combined capacity for transport and cooling and testing milk quality. Next, I looked at efficient utilisation of cooling machines. Again, the larger collectors used the capacity better than the smaller ones, but the contribution to CO_2 emissions per kilogram of milk cooled is much smaller.

I also looked into the emissions of processing. Here it looks like the bigger processor is using more energy per kilogram of product. This may have to do with frequent electrical power interruptions, leading to more fuel emissions from the generator at the larger processor. Also, the emissions from firewood in preparing cottage cheese by the smaller processors were not considered. On this point, I recommend additional research.

The losses in the dairy chain are related to milk quality, and this also affects the emissions per unit of product. Processors mentioned the lack of chilled transport, the limited capacity for testing, interrupted water and electricity supply and lack of packaging materials. It is important to mention that cooling after processing is important, because of the many days of fasting for Ethiopian Christians.

In the study area, there is also a side market for ergo, which is fermented milk similar to yoghurt. I noted some small milk bars in the study area that serve ergo and boiled milk. This segment is another area for further research."

Read more:
Thesis of Godadaw Misganaw

GHG emissions in collection and cooling

	Large collectors	Small collectors
Collection of milk	(n=13)	(n=15)
Milk collected (l/yr)	2,169,440	281,892
Fuel consumed (l/yr)	20,566	11,898
CO_2 emission (kg/yr)	49,886	29,871
Emission (CO_2eq/kg FPCM)	0.021	0.089
Cooling at collection centre		
Milk cooled (l/yr)	1,228,955	187,610
Energy (Kwh/yr)	76,268	11,898
CO_2 emission (kg/yr)	9,915	1,547
Emission (CO_2eq/kg FPCM)	0.0081	0.0083

Insight into the carbon footprint of dairy

Life Cycle Analysis

The CSDEK partners applied the Life Cycle Analysis (LCA) in their research on climate-smart dairy practices. LCA is a standard that follows the IPCC 2006 guidelines. LCA sets a system boundary (around a farm or a production chain) and then accounts for the emissions of all the inputs and outputs in the system. In dairy studies, these emissions – or the carbon footprint – are usually expressed in CO_2 equivalents per litre of fat and protein-corrected milk (FPCM). For example, 1 kg of methane is 25 kg of CO_2. The emissions vary with the fat and protein content of the milk. The world average is 2.4 kg CO_2eq/kg FPCM at the farm gate.

FAO data indicate that the emission intensity of milk in Ethiopia is on average 24.5 kg CO_2eq/kg FPCM depending on the production system. Emissions in mixed crop and livestock systems average 44.6 kg CO_2eq/kg FPCM, while medium-scale commercial systems reach 3.8 kg CO_2eq/kg FPCM. In Kenya the national average emission intensity is 3.8 kg CO_2eq/kg FPCM with a range from 2.1 kg CO_2eq/kg FPCM in intensive systems to 7.1 kg CO_2eq/kg FPCM in extensive grazing systems.

There are three levels of accuracy in calculating emissions:

- Tier 1 of the LCA is based on default emission factors for dairy cows.
- Tier 2 considers country-specific data on feed intake, methane productivity and herd composition. This is what the CSDEK partners use.
- Tier 3 measures emissions of individual cows, thereby accounting for health status, feed composition and the rumination process.

Read more:

> Calculation-tools
> IPCC Fifth Assessment Report
> IPCC Guidelines for National Greenhouse Gas Inventories

Carbon footprint and multifunctionality

How can the emissions from dairy in a multifunctional farming system be assessed? A study led by **Viola Weiler** from 2013 allocated emissions for the marketed products, for livelihoods and also for socio-cultural values. In the analysis of a sample of typical Kenyan smallholders, this resulted in very different carbon footprints of milk. As might be expected, disregarding the multiple functions of cattle results in higher carbon footprints of milk production. Multifunctionality also considers home consumption of milk and dairy, something often overlooked when comparing production strategies.

Read more:

> Journal article co-authored by Viola Weiler

Carbon footprint and feeding strategies

Can smallholder dairy farms reduce the carbon footprint by feeding cows differently? A study by **Andreas Wilkes** from 2020 compared the data from 382 farms in central Kenya. As expected, at the level of individual cows, variation in milk yields explained more than 70% of the variation in GHG emission intensity. The average carbon footprint ranged between 2.19 and 3.13 kg CO_2eq/kg FPCM. The analysis showed that the carbon footprint was higher on farms with grazing-only feeding systems than on farms with zero-grazing systems. Interestingly, feeding more concentrates was also correlated to a higher carbon footprint. The findings suggest that promoting balanced feed rations and feeding concentrate according to cows' needs across the lactation cycle could provide opportunities to both increase milk production and reduce the carbon footprint of milk production on smallholder farms in central Kenya.

Read more:

> Journal article co-authored by Andreas Wilkes

Business uptake of climate-smart dairy practices

Climate-smart dairy practices described in the previous chapter can also be smart from a business perspective. This is true when the productivity increases, when the production costs go down or when losses of raw milk in the chain are reduced. In the longer term, climate-smart dairy practices make business sense because they can reduce risks, for example anticipating changes in rainfall patterns. So why haven't these smart practices been widely adopted already?.

One issue is the structure of the dairy sector. Most of the milk is produced by smallholders and is marketed through informal channels. This part of the sector is not well represented in the dialogue about dairy development. This is a challenge for the CSDEK partners in all the milksheds. Dairy farmers who are organised in cooperatives are better off in two ways. The marketing of their milk is taken care of, and the price is usually more stable. The second benefit is the access to various services and inputs. In situations where input and service provision are underdeveloped, dairy cooperatives can provide the business solutions that farmers need. In due course, commercial providers may outcompete the cooperatives.

The other issue is access to finance for climate-smart solutions. The available cash at the farm is already used to keep dairy production going or for household expenditure. Many financial institutions are reluctant to lend to dairy farms – or for agriculture in general – due to the many risks and high transaction costs involved. Smallholders with no assets or proven credit history have particular difficulties in getting a loan. Again, joining a dairy cooperative helps: production records are kept and many cooperatives have set up financial services to members.

The CSDEK research is concerned with the ways existing business models contribute to climate-smart outcomes and the key barriers to and triggers for scaling up effective business models. In this chapter, four students from Van Hall Larenstein University (VHL) and Jimma University analyse the business and climate-smart performance of farmers in the Kiambu-Githunguri and Ziway-Hawassa milksheds.

Economic performance and carbon footprint

Blessing Mudombi assessed the impact of climate-smart practices within dairy farming systems. She analysed the economic and environmental costs, benefits and performance of seven urban and peri-urban dairy farms in the Ziway-Hawassa milk-shed. The farms differed in size and production level. Crop residues were the main form of roughage, and this was supplemented with concentrates.

Climate-smart practices included the use of high yielding cross-breeds, zero-grazing units, use of concentrates and artificial insemination. Concrete floors in the cowshed allowed for the separation of urine and manure, which is important to reduce GHG emissions. Cost price was lowest in farms that had high milk productivity per cow. The carbon footprint is also related to a series of other factors.

Blessing: *"In our analysis, we looked first at the economic and zootechnical indicators and noted that three farms have costs above the farmgate milk price. The quick analysis is that when cows give less than 5 kg of milk, the farm operates at a loss. But we also looked at farm herd composition. When you have cows with long dry periods between lactations, revenues will be below potential. Also, a higher replacement rate implies more costs due to having youngstock instead of sales. A third factor affected the peri-urban farmers, who could not rely on artificial insemination for their herd. They have the extra feeding costs of keeping a bull, and they miss out on improved breeds. Some farmers had extra costs due to mastitis.*

Then we looked at the climate-smart practices on these farms. We noted some good things. Based on these different climate-smart practices, the carbon footprint was calculated. There is significant variation between farms. Not all farmers have adopted all practices yet, which means they can learn from the best-performing neighbours to manage cost price, productivity and the carbon footprint per litre of milk.

My advice for both urban and peri-urban farmers is to focus on better feeding. If you have land, grow fodder yourself; otherwise find a reliable supplier of fodder. High-quality fodder available year-round will increase productivity through young age at first calving, short calving interval and higher milk yield. It will also reduce GHG emissions in the cradle-to-farmgate phase and increase profit per litre for the farmer."

Farm code	Herd size (Head)	Milk yield (Litres/ farm/yr)	Production cost (ETB/litre)	Total revenue (ETB/litre)	Carbon footprint (CO_2eq/ kg FPCM)
Eth1	4	3,500	32.31	25.25	4.42
Eth2	29	49,773	20.27	21.31	1.70
Eth3	12	18,675	19.10	22.76	2.15
Eth4	19	12,835	42.16	28.17	5.07
Eth5	64	110,079	19.00	26.75	1.47
Eth6	34	47,460	18.48	22.81	1.76
Eth7	16	15,617	38.32	27.60	3.29

currency: ETB 20 = € 0.545 = KES 63.70

Read more:
Thesis of Blessing Mudombi

Modelling GHG emissions, cost and benefit analysis

In 2019, **Anastasia Vala** analysed in detail the business and climate-smart strategies of six dairy farms around Githunguri and Olenguruone. All six farms used zero-grazing or paddock systems. The farms were very different in herd size (4–79 cows), production per cow (1,120–5,475 litres per lactating cow per year) and cost price (KES 16.95–49.00 per litre).

All farmers ranked feeding as their top priority, but they followed different strategies: hiring extra grassland or buying extra hay, concentrates or by-products like brewer's yeast, pineapple waste and poultry droppings.

Other climate-smart investments included biodigesters, water harvesting and solar panels. These investments reduce the energy running costs by replacing fossil fuels and may benefit other farm activities and the household.

Farm code	Herd size (Head)	Milk yield (Litres/ farm/yr)	Production cost (ETB/litre)	Total revenue (ETB/litre)	Carbon footprint (CO_2eq/ kg FPCM)
Ke1	66	204,316	16.95	41.90	1.05
Ke2	4	2,240	82.55	66.00	2.49
Ke3	5	9,553	32.50	84.56	1.40
Ke4	79	187,610	36.82	50.86	1.12
Ke5	18	43,800	49.17	54.09	1.14
Ke6	6	16,245	13.32	43.60	0.38

currency: KES 50 = € 0.428 = ETB 15.70

Read more: Thesis of Anastasia Vala

Anastasia: *"My champion farmer is a family from Githunguri. On just 3 acres they keep 57 cows, 40 in milk with an average 3,584 litres/year. The farm had water harvesting tanks, biodigesters and agro-forestry, and they used artificial insemination and vaccination for healthy cows. They reduced costs by feeding the cows brewer's yeast and pineapple waste. All these practices also help reduce GHG emissions.*

According to our calculations, the GHG emissions from the six farms varied between 0.38 kg CO_2eq and 2.49 kg CO_2eq per kilogram of standard milk. The high score comes from a small farm with two dry cows in a herd of four. The low score is from a farmer who avoids concentrates and only feeds fodder legumes. Here it is clear that the higher milk production has the lower emission per kilogram. Also, poor quality fodder increases CH enteric emissions. The variation between the six farms shows that there is a lot to be gained from comparing and sharing the best practices in feeding to overcome the challenges of climate-smart dairy.

The farmers should also consider the economics of biodigesters, water harvesting and solar panels. Biodigesters capture methane from manure and can be used to cook and light the home and dairy shed, hence reducing electricity bills. The remaining bioslurry can fertilise the crops, replacing synthetic fertilisers.

Water harvesting is important, as dairy cows require water throughout the day. Water is the principal constituent of milk. Solar panels will help the farmer reduce electricity bills for heating water to clean the milking equipment and pumping water. Solar can also bring electric power to the household."

The feeding qualities of straw

Shigut Dida conducted his study in Assela and Jimma milksheds. Assela has a big dairy herd, space for fodder production and good infrastructure 175 km from Addis Ababa. Nearby are an animal feed factory and suppliers of suitable by-products from other industries. The Jimma milkshed, 350 km from Addis Ababa, is smaller and combines dairy with cash crops like chat and coffee. There is a lower availability of concentrates and high-quality fodder. Comparing the two study areas, the Assela milkshed is best developed. In the Jimma milkshed, the dairy is competing with cash crops. In both milksheds, the biggest challenges are to do with feed availability and cost of production.

Shigut analysed the structure of the feed value chain, including the availability of crop residues in both milksheds. Crop residues are the fibrous by-products that result from the cultivation of cereals, pulses, oil plants, roots and tubers; they are an important feed resource.

Read more by contacting: eyerus.muleta@ju.edu.et

Shigut: *"In the Assela milkshed, the crop residues available for dairy animals are wheat straw, barley straw and occasionally teff straw. The use of combine harvesters makes it easier to collect and store the straw. In Jimma the available items are maize stover and sorghum stover. Harvesting is done by hand, and most farmers leave maize and sorghum stover on the field. Animals graze the residue, which results in feed wastage. Teff is grown in the Jimma area, but the straw here gets sold for mud house construction.*

Feeding straw or other crop residues with poor digestibility is not the best option. But the farmer's choice is understandable when there is no quality feed available. In that case, feeding straw is the only option. What is needed here is to develop fodder alternatives with better digestibility."

Improving fodder availability makes economic sense, as the increase in milk production easily pays for the extra feeding costs above maintenance. This is a comparison between poor feeding and optimal feeding.

The environmental dimension of feeding straw to animals is another comparison. Straw can be fed to animals, but it can also be directly used to mulch and improve the soil structure. Feeding straw is a better than burning or selling it, as it can help close the farm nutrient cycle, especially when manure is applied to crop fields. As a rule of thumb, dairy animals can just survive on straw, although there are huge differences in digestibility. Many smallholder farmers complement the ration of straw with energy-rich concentrates or by-products like spent barley.

Finance for climate-smart dairy

In his BSc thesis, **Wout van der Sanden** looked into access that members of the Githunguri and Olenguruone dairy coops had to finance to invest in climate-smart solutions.

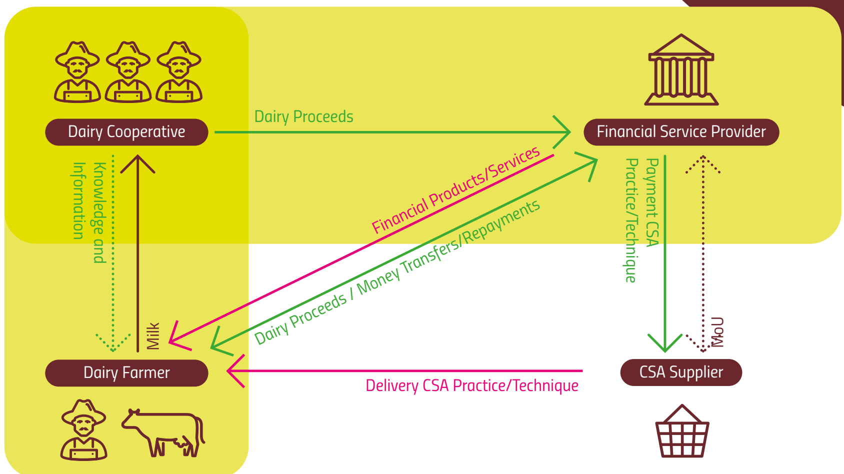
Cooperative dairy farmers have a steady income from dairy. The Githunguri coop sells processed milk to consumers, so they offer a farm milk price which is above market. Both coops disburse the milk proceeds every month. The cooperatives allow their members to buy dairy farm inputs and food items on credit. Every member has a threshold level in the “check-off system”, depending on the milk supply. The estimated costs of the different climate-smart dairy solutions are much higher than the average farm’s month of milk supply. So other financial services are required. In the study, Wout interviewed farmers and financial service providers about their interest in climate-smart investments.

Wout: *“In the interviews, the farmers mentioned biodigesters, rainwater harvesting, milking bucket machine and/or maize silage. So I focused on these. But I also observed other solutions like boreholes, water pumps and chaff cutters. It was difficult to estimate average expenses, as interviewees mentioned different characteristics and operate in different contexts. So I worked with a cost range. I also noticed that only very few farmers actually invested in one of these solutions.*

On the other hand, interviews with banks and micro-finance institutions indicated that climate-smart dairy solutions are not a priority for most of the financial service providers. Allegedly, there is no demand for such financial services, and that is the most important barrier for the development of financial products related to climate-smart agriculture.

Parties who have a direct stake in increasing the adoption rates of climate-smart solutions are the suppliers of these inputs. In the longer term, it is also in the interest of the cooperatives to increase the resilience of the milk supply.”

A way to trigger demand for climate-smart solutions is to apply the principle of “value chain finance”. This principle could be enacted through a tripartite arrangement between the dairy cooperatives, climate-smart solution suppliers and financial institutions. The dairy cooperatives bundle demand among their members for a better deal with the suppliers and guarantee payments based on a longer term check-off system. Such a business deal should be attractive enough for microfinance institutions or banks that can pre-finance and get paid in due course via the cooperatives.



Read more:
Link to thesis

Insight: Can dairy benefit from climate finance?

According to a study in 2019 by **Charles Odhong** and others at UNIQUE, dairy farmers in Kenya mostly rely on their own savings and current income as funding sources for farm investment. Dairy is a profitable and growing business, but financial institutions perceive a number of risks in this sector. This disconnect between farmers and finance contributes to the low adoption rate of climate-smart dairy practices.

The study collected data on this issue through surveys with dairy farmer households, dairy cooperatives and financial institutions. Calculations show that climate-smart investments costing between USD 1,457 (for zero-grazing housing) and USD 2,875 (zero-grazing housing, biogas and fodder production) have internal rates of return between 25% and 31% and a break-even after five years.

Further analysis of cashflows in these investment scenarios points to constraints on using formal credit to finance these investments. Commercial credit is too expensive. Most farmers use their own income resources for the dairy operation itself, leaving little room for investment. Cooperatives are in a similar situation: strapped for cash. Their in-kind lending of inputs to members against milk delivery (the check-off system) ties up working capital. Dairy cooperatives like Githunguri have set up savings and credit cooperatives (SACCOs). These dairy-related SACCOs offer loan products for the dairy sector and are generally more flexible in their lending practice. Some SACCOs act as on-lenders for banks, which trust that the deeper understanding SACCOs have of the dairy business helps the banks to assess and manage the risks.

Climate finance has the objective of promoting low-emission, climate-resilient transformation. To achieve this public interest, providers of climate finance may offer lower interest rates and longer terms. These providers may use mechanisms such as loans, equity, guarantees and grants that are common in agricultural finance, and they may use the dairy-related SACCOs as on-lenders.

These public sources of climate finance could help link dairy farmers to financial institutions by:

- supporting savings and credit groups that use group lending models for dairy farmers
- strengthening the capacity of cooperatives to render services to members and to track and demonstrate member financial performance
- strengthening the agricultural know-how of financial institutions and nurturing a learning culture among agricultural practitioners
- managing the risks by linking credit to technical assistance, blended financial products and financial literacy of clients.

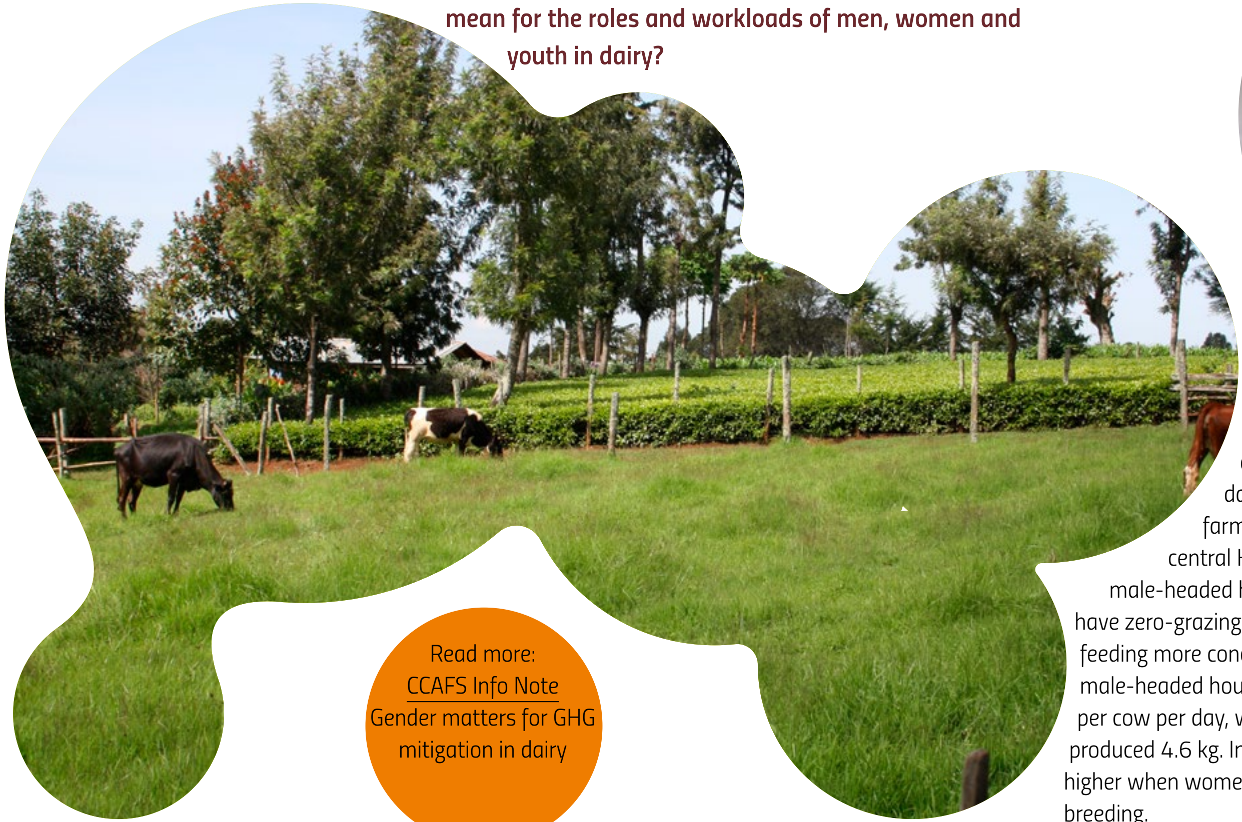
Climate-smart investments in the dairy sector can make a big difference in a short period. The variation found in dairy farm performances as presented in the previous pages indicates an opportunity for profound sector transformation.

Read more: Journal article co-authored by Charles Odhong

Risks, constraints	Financial institutions' perceptions
Production risks	Weather, animal disease, poor management leading to low yields/fluctuations in yields impacting on repayment ability
Market risks	Market and price fluctuations impacting on repayment ability
Information risks	Poor record keeping, limited visibility of farmers' financial records
Constraints to expanding credit supply	Limited credit lines; multiple borrowing leading to default; high transaction costs of outreach to farmers; high cost of funding leading to high interest rates on loans; competition among financial institutions; inadequate funds for on-lending
Constraints to farmer access to credit	Insufficient collateral; income fluctuations impact on ability to repay; farmers' low literacy levels

Inclusiveness and climate-smart dairy

Sustainable intensification of the dairy sector aims to reduce its carbon footprint; the previous chapters describe a number of practices to this end. Most of these climate-smart practices also mean more farm work. What does dairy intensification mean for the roles and workloads of men, women and youth in dairy?



Read more:
CCAFS Info Note
Gender matters for GHG mitigation in dairy

In 2020, CSDEK partner UNIQUE looked into the gender dimension of climate-smart dairy by surveying 382 dairy farm households with 702 cows in central Kenya. The findings showed that male-headed households were more likely to have zero-grazing feeding systems, and they were feeding more concentrate to the cows. On average, male-headed households produced 6 kg of milk per cow per day, while female-headed households produced 4.6 kg. Interestingly, milk yields were higher when women made decisions over cow breeding.

The research shows that women obtain higher prices when they sell milk, although milk sales by women are associated with lower yields. This has to do with women's preference for sales to informal markets that have higher average prices.

Milk yields are higher for households that sell to the formal market, and these households are also more likely to have zero-grazing in place. The men in these households may prefer the cooperatives, which accept larger volumes of milk and give them control over milk income.

This means that there may be a trade-off between increasing milk yield (and thus reducing carbon footprint) and benefits for women. Female ownership of cooperative payment accounts is associated with higher milk yields. In short, a dairy cooperative with a gender-sensitive approach to its members may have a business benefit in terms of higher milk intake.

In this chapter, four students from Van Hall Larenstein University (VHL) and Jimma University report on the inclusiveness aspects of climate-smart dairy practices found in Kiambu-Githunguri and Ziway-Hawassa milksheds.

The only chance to generate income is to process the milk

Mina Hassn analysed the gender dimension of climate-smart dairy in the Ziway-Hawassa milkshed. She conducted in-depth interviews with six male and six female dairy farmers and 11 other informants in the dairy sector. Her questions to males and females were about their awareness, knowledge and skills in relation to dairy and climate change. Mina also held five focus group discussions in Adami Tullu, Shashemene and Arsi Negele districts.

According to the interviews, women participate in almost all dairy practices, from caring for and feeding the cows to milking and selling milk and milk products. Men usually purchase and transport feed and choose the type of breed. Women do not have power to sell milking cows without the consent of the men. Some bigger farmers hire young men to do the work with the animals.

Mina: *"The cooperative people, extension agents and researchers all confirmed that women and youth are a priority in the activities. But they also admitted that their participation is low, since women are busy in their homes, and youth are not very enthusiastic about farming and dairy. Five of the key inform-ants indicated that women accept and adopt new technologies easier than men. Moreover, youth are using modern technologies and the internet to get information. Both men and women stated that the main barrier to increasing their milk production is the shortage of land. The farmers use communal land for grazing or feed cut-and-carry fodder or crop residues from their farms or they purchase fodder. The manure is mostly used as fertiliser for maize, teff and vegetable production, while some use dried cow dung as a source of fuel. Only one farmer uses biogas."*

One female farmer explained to Mina: *"All the people in the community here have dairy cows, so no one buys milk for the household. My only chance to generate income is to process the milk into butter and traditional cheese and sell it on market days. Processing is one way of making the milk keep longer."*

Read more: Thesis of Mina Hassn

Dairy activities based on gender

Activities	Male-headed households		Female-headed households	Both types of households	
	Male	Female	Female	Youth male	Youth female
Manure collection		✔	✔		✔
Making dung cake		✔	✔		✔
Feed selection	✔		✔		
Feed transportation	✔		✔	✔	
Selection of cow breed	✔		✔		
Cleaning		✔	✔		✔
Feeding		✔	✔		✔
Herding		✔	✔	✔	
Milking		✔	✔		
Milk selling		✔	✔		✔
Milk processing		✔	✔		

The women do most of the work

The study by **Tamirat Kebede** identified the gender roles in and carbon footprints of milk production in Assela and Jimma milksheds. He interviewed 124 milk producers and held discussions with key informants.

To quantify the carbon footprint, Tamirat used the LCA Tier 2 approach (see page 14).

Income from dairy is more important for the dairy households in Assela milkshed than for those in Jimma milkshed. The milk production in Assela households averaged 8.78 litres per cow per day, and in Jimma it was 5.13 litres. In both milksheds, female family members do most of the work: cleaning the barn, milking, milk processing and selling. There was a remarkable difference in awareness about climate change among interviewees. Urban female dairy farmers from Jimma milkshed were the least aware of this topic.

The major finding from this study is that the emission intensity of milk was 1.4 kg CO_2eq/kg FPCM in Assela and 3.5 kg CO_2eq/kg FPCM in Jimma. As supported in the literature, it was found that higher producing animals give a lower carbon footprint per litre of milk. The calculations also show that a small increase in productivity causes a remarkable reduction in the carbon footprint per litre. However, the difference in carbon footprint is in large part explained by the animals in the Jimma herds that are not producing milk. The manure management is similar in the two milksheds: the dominant method is solid storage, while biogas installations are rare.

Tamirat: *"Awareness about climate change was higher in Assela for both men and women. This is possibly thanks to the work done by different NGOs. In Jimma, women may have had fewer opportunities for training about climate change, mitigation and adaptation.*

In the Jimma milkshed there are more non-productive animals. These animals do not produce milk, but the bulls do produce offspring, and oxen produce draught power. We did not apply the multifunctionality approach in the LCA. But my recommendation is to improve the availability of artificial insemination in Jimma, which will bring the number of bulls down. And the advancement of mechanisation will reduce the need for draught oxen. Their feed can go to the dairy cows, which will improve productivity and reduce the carbon footprint."

Read more by contacting: eyerus.muleta@ju.edu.et

Gender in dairy farming

In Kenya, **Florence Aguda** used – like Mina Hassn in Ethiopia – a qualitative approach to understand gender relations in the Kenyan dairy sector. She interviewed 12 male and 12 female smallholder dairy farmers, as well as eight key informants in Githunguri and Olenguruone. She also held focus group discussions in both areas.

The findings show that women do most of the work but do not own the dairy assets of land, cattle and equipment. Women and men agree that fodder conservation is the most important climate-smart practice. Many dairy farmers engage in silage-making after the rainy season. This is an adaptive strategy that can be scaled up, although women especially consider it hard work.

Members of the dairy cooperatives are mostly men. This means that the check-off system under which people can be advanced animal concentrates and domestic food items is mostly available for men. The Government of Kenya's policy on gender states that at least 30% of staff in all establishments are female. The dairy cooperatives employ many women, but mainly in supportive hands-on work and not at decision-making level. The dairy cooperative has no gender policy in place.

Florence: *"What I learned from all the interviews is that women have to do the work but have no decision-making power. The focus groups indicated that cattle ownership is considered a status symbol for men. Cattle are used as dowry payment and therefore cannot owned by women. The same cultural laws prohibit women from owning land. This explains why more women than men are hiring or leasing land for fodder production.*

My recommendation is for the dairy cooperative: they should start to register the women and focus on their role in the milk production process. The extension staff should redirect the training to the group that does the work, and that is mostly the women. Today, women get their information on dairy production from informal sources such as neighbours, family and other dairy farmers. Targeted training will yield better returns."

Read more:
Thesis of
Florence Aguda

Inclusiveness and the knowledge system

Agricultural education is the way to advance the inclusion of youth in the dairy sector. **Catherine Wangila** studied how higher education, vocational education and research integrate climate-smart dairy in their work. She interviewed 32 knowledge professionals from a range of organisations in Kenya.

At the national level, climate-smart dairy research at the International Livestock Research Institute and at the Kenya Agricultural & Livestock Research Organization is focusing on low carbon emissions, on improving fodder and on breeding strategies.

Most Kenyan universities and TVETs do teach about climate-smart agriculture, although it is yet not fully integrated in the curricula. In addition, some climate-smart technologies have been practised on their livestock farms.

The knowledge organisations that have climate-smart agriculture activities near Kiambu County are the Dairy Training Institute in Naivasha, Egerton University Nakuru Campus, Wangari Maathai Institute (part of Nairobi University) and the Animal Health and Industry Training Institute in Kabete.

Catherine:
"Most of the professionals in the knowledge systems I interviewed were aware of climate-smart agriculture. They mentioned first the practices to reduce water loss and increase water retention, like terracing and contour bands. Manure application was mentioned; the collection of manure is easy in zero-grazing systems. They use it for growing improved fodders such as Napier, maize, Boma Rhodes grass, lucerne and Desmodium. They also mentioned the choice to keep high-yielding animals and use artificial insemination. I conclude that much needs to be done on up-scaling, hence the concerted efforts from all knowledge actors.

My recommendations are about supporting educational institutions and small-scale farmers. For example, biodigesters are a national priority for renewable energy, so farmers were expecting to be supported. When donors didn't show up, the adoption rate never picked up. My top recommendation is that youth in agriculture should be a priority. I consider them our future farmers. With their energy, if they are educated to treat agriculture as a business, they can make climate-smart agriculture up-scaling a success."

Read more:
Thesis of
Catherine Wangila

Scaling and impact

The previous chapters have highlighted the environmental, business and social dimensions of climate-smart dairy. The CSDEK programme generated these insights to trigger scaling of sustainable development in the dairy sector. Scaling is playing out differently for the various partners in the six milksheds under the CSDEK programme.

In the Kiambu-Githunguri milkshed, the Githunguri Dairy Farmers Cooperative Society has a lead role in promoting climate-smart practices among farmers. The cooperative has its own offer of training, extension and financial services and a role as a business partner for input suppliers, service providers, donors and authorities.

In the Ziway-Hawassa milkshed, private processors dominate the market although there are small dairy cooperatives. An entry point for promoting and scaling climate-smart dairy may be through the Farmers Research Groups in the milkshed. These are linked to the Atami Tuli Agricultural Research Centre.

There is also uptake of climate-smart dairy as a topic among the education and research partners. Van Hall Larenstein University (VHL) has bundled all the MSc theses under CSDEK in this publication. Further results are expected from the three PhD researchers who started under CSDEK. The next pages include reflections and testimonies from the various actors, and ideas about how the fruitful interaction between them may continue.

Download CSDEK practice briefs

Scaling climate-smart dairy through the Living Lab approach

This magazine lists the climate-smart dairy practices available for farmers in the milksheds. An overall conclusion is that the adoption level of these practices is generally low, as it is for the practices that are business-wise. There are different bottlenecks that explain this. First, any new climate-smart practice comes with (upfront) costs, benefits and risks. The appreciation of these costs, benefits and risks is influenced by a range of actors. For a dairy farm household, these influencers may include neighbours, family, model farmers, feed and input suppliers, milk buyers, trainers, teachers, researchers and authorities. How can these actors support dairy farm households to adopt climate-smart practices? And how can knowledge institutes be partners in this process?

VHL adopted four design principles for Living Labs:

1. **Inclusive participation: multiple actors, linking working and learning**
2. **A focus on learning for a sustainable future, like the Sustainable Development Goals**
3. **Commitment to co-create and monitor a shared learning agenda**
4. **Facilitation of interaction and knowledge sharing.**

Living Lab concept

Van Hall Larenstein University (VHL) is proposing a Living Lab approach. In a Living Lab, private sector, government organisations, community-based organisations and knowledge partners collaborate in applied research projects for sustainable development. The ambition is to organise Living Labs as a follow-up to the CSDEK research. This would result in continued learning networks with farmers and their organisations, businesses and knowledge partners active in the milksheds in Ethiopia and Kenya.

The CSDEK research has worked on the first two principles and created an overview of actors and their available options in terms of climate-smart dairy. The next step is to create a learning agenda with the actors. This agenda will be centred around a theory of change that includes both technical solutions (what) and methodological solutions (how). Such an agreed and shared theory of change would prioritise the available options for sustainable development in the milkshed and steer the learning and research topics of the international dairy programmes at VHL and the Ethiopian and Kenyan knowledge partners.

Marco Verschuur (PhD candidate)
Coordinator Master Agricultural Production Chain Management
Van Hall Larenstein University of Applied Sciences

Scaling in the dairy chain

For our cooperative, the greatest impact accrued from the CSDEK research project is knowledge and information sharing with the students and the universities. This has influenced our approach to training staff and members towards achieving climate-smart agriculture objectives. As a result, the cooperative has instituted the following interventions:

1. *Collaboration with Waruhiu Agriculture Training Centre as our training centre for staff and farmers on animal husbandry and climate-smart agriculture*
2. *Collaboration with Keilot Kenya Ltd, a clean energy solutions company, which has enabled members to purchase climate-smart agriculture products on soft loans*
3. *Fodder conservation adoption, especially of maize silage. We are encouraging members to switch from Napier to maize silage. Maize is more nutritious and contributes less to greenhouse gases.*
4. *Our breeding with artificial insemination is focusing on smaller cows. A reduced body size will improve the feed conversion and increase productivity.*

However, the greatest challenge faced by our members is disposal of manure, which is abundant. We look forward to having more fruitful and engaging sessions with VHL.

Francis Muhande
Quality Assurance and Extension Services Manager | Githunguri Dairy Farmers Cooperative Society Limited

The results of the CSDEK research project on our work with the Farmers Research Groups was:

1. *The VHL students collected detailed information about climate-smart practices from farmers, transporters, processors and the professionals in the support organisations. This gave us a good overview. The emphasis is on climate smartness while boosting productivity.*
2. *VHL also brought the actors together in a refresher course on dairy. We participated and were inspired by the exchange of ideas. Since then, we have included climate-smart dairy practices in our work with the Farmers Research Groups.*
3. *Our research centre included the climate-smart agriculture concept in new research proposals for dairy, but also for meat, poultry, apiculture, animal feeds, natural resource and crop production.*

Shimelis Gizachew Desalegn
Researcher | Adami Tulu Agricultural Research Center

In 2020, Ethiopian experts compiled a Tier 2 national livestock greenhouse gas inventory that referred to two VHL Master theses conducted in the Ziway-Hawassa milkshed and commissioned through the CSDEK project. One was by Biruh Tezera: "Carbon footprint of milk at smallholder dairy production"; the other was by Blessing Mudombi: "Cost–benefit analysis and GHG emission in dairy business models". The inventory underwent validation by national experts later in October 2020 before being officially accepted by the Ministry of Agriculture and by the Environment, Forestry and Climate Change Commission. This is good news, as it is why we are doing all this: for uptake of our research efforts.

Andreas Wilkes
Associated expert | UNIQUE Land Use and Forestry GmbH

Scaling through education and applied research

The logo of VHL includes a green footprint as a symbol of its commitment to sustainable development and climate-smart agriculture in the Netherlands and in the international courses. This commitment is not exceptional, as many organisations in the VHL network look for ways to introduce and scale climate-smart practices. The quest is for innovations that are sustainable from an environmental perspective while maintaining income and return on investment. At the start of CSDEK the project partners expected to study and analyse this type of innovation with dairy farmers and their organisations, with dairy professionals in support roles and with our international dairy students.

A rather unexpected scaling pathway was how climate-smart dairy consolidated as a topic within VHL. The CSDEK project had a catalysing effect on the study programmes and professorships of VHL.

- In 2017, when the CSDEK proposal was written, climate-smart dairy was piloted as a leading topic in a three-week course in the Master of Agricultural Production Chain Management (APCM). That first year, the course taught 20 students from Africa and Asia, and it has been repeated every year. The course is an influential channel to promote climate-smart dairy, as APCM graduates (eventually) hold senior positions in their respective institutions.
- The second concrete step was the establishment of the professorship "Climate Smart Dairy Value Chains". A second professorship, "Sustainable Agribusiness in Metropolitan Areas", joined in all activities.
- During the period 2018–2020, 12 VHL Masters students completed theses through the project. These theses culminated in a compilation of practice briefs that were widely shared among alumni networks. Several CSDEK partners were involved in the assessment of these theses.
- Across 2019–2020, the topic of climate-smart dairy was further incorporated in the study programmes Animal Husbandry and Innovative Dairy Chain Management.
- The topic of climate-smart dairy was further expanded through 10-day training courses for VHL, Wageningen University and Research (WUR), AERES PTC+ alumni in Ethiopia and Kenya, with 25 participants in 2019 and 40 in 2020.
- Together with universities and dairy actors engaged in CSDEK, VHL is proposing to continue the joint learning by establishing local Living Labs in Kenya and in Ethiopia (see page 24). A Living Lab is a long-term learning and sharing platform, but CSDEK gave this idea the initial boost. The involvement of VHL dairy alumni is a further asset in this process. Also, key partner Agriterra is supporting the Living Lab approach and adding research topics from their practice with cooperative development.

What started as an externally funded project to be implemented with overseas partners became a journey in our own university that changed the position of climate resilience in our courses and applied research. Climate resilience and climate-smart solutions were new topics only five years ago, but now it would be unthinkable to have dairy courses at VHL without them. CSDEK may end in December 2020, but there is a lasting commitment among VHL staff, students, alumni, project partners and network partners to continue the journey for climate-smart dairy.

Robert Baars
Professor Climate Smart Dairy Value Chains
Van Hall Larenstein University of Applied Sciences

Scaling climate-smart dairy through VHL education and applied research

Action at VHL	Output by 2020	Impact
Climate-smart dairy integrated into **education**		
Agricultural Production Chain Management (APCM) Master programme (2017 onwards)	30 international students per year = 120 alumni in 2020	▪ Alumni in senior positions in public and private organisations include climate-smart dairy in their decision-making
Innovative Dairy Chain Management (IDCM) Master Programme (2020 onwards)	20 Dutch and international students in 2020	▪ in due course
Dairy alumni refresher courses (2019 and 2020)	60 alumni from VHL, WUR, AERES PTC+ trained by 2020	▪ 250+ alumni self-organise in lifelong learning platform ▪ Alumni advocate for climate-smart dairy training and solutions
APCM and MOD Master theses (2018–2019)	12 theses on climate-smart dairy completed in 2020	▪ Practice briefs of all theses published and shared online (50+ views/month)
Climate-smart dairy integrated into **applied research**		
Professorship Climate Smart Dairy Value Chains (established 2019)	▪ Setting agenda for applied research ▪ Network partners involved in theses assessment	▪ Climate-smart dairy awareness up and solutions introduced to >1,500 dairy farmers in six milksheds in Ethiopia and Kenya ▪ >10 dairy chain actors ▪ >10 knowledge partners ▪ Start of at least two dairy Living Labs in Africa with active involvement of VHL alumni and network partners
Professorship Sustainable Agribusiness in Metropolitan Areas involved in CSDEK (2018–2020)	▪ Co-design of Living Lab approach	

Eyerus Muleta, from Ethiopia, is a PhD candidate at Jimma University under the CSDEK project. *"Since the start of the CSDEK applied research project, our department at Jimma University feels it is important to include climate-smart dairy as a chapter in our existing courses or as a new course. However, the formal curriculum review is harmonised at the national level, so that is a lengthy process. Meanwhile, my PhD on this topic helps me to understand the concept and discuss the issue with my colleagues and with students. Interestingly, we discovered that climate-smart is not opposed to business-wise. In fact, many practices that increase animal productivity and benefit dairy farms also contribute to reduce carbon emissions.*

CSDEK also inspired me and my colleagues to develop a staff research project on climate change mitigation in dairy cattle husbandry."

Eyerus Muleta Fatula (PhD candidate)
Lecturer at Department of Animal Science
Jimma University College of Agriculture and Veterinary Medicine

Francis O. Oduor is a PhD candidate from Kenya under the CSDEK project. His PhD research is with Moi University, and he teaches at University of Kabianga – School of Agriculture and Biotechnology.

"Based on my PhD research in the context of CSDEK, we introduced a new course here at the University of Kabianga. It is called Agrifood Supply Chain Management. The first cohort of students are doing their exams in October 2020. The concepts of climate-smart agriculture and sustainable dairy intensification are also influencing four existing courses: Arid and Semi-arid Land Management, Fodder and Pasture Management, Perennial Crops, and Urban Agriculture.

Our next challenge is to introduce the quantification of GHG emissions from animal and crop production."

Francis Onyango Oduor (PhD candidate)
Lecturer at School of Agriculture and Biotechnology
University of Kabianga

The CSDEK project resulted in several climate-smart business models and innovations for farm management. The next challenge is to implement and scale up these innovations in farming communities and the dairy sector in Ethiopia and Kenya. Successfully implementing innovations requires real commitment from frontrunner farmers and their organisations that act as showcases for others. It also requires the integration of experts' knowledge and tacit knowledge from practitioners, because contextual knowledge – about soil, climate and sociocultural systems of specific regions – is crucial for successful implementation. Also, successful implementation and up-scaling requires involvement of all "quadruple helix partners", from the dairy sector, government, knowledge and civil society. For farmers to invest in innovative technologies or methods, the return on investment should be guaranteed; regulations and policy should be supportive; knowledge should be available; and innovations should be accepted by the community. The Living Lab approach focuses on specific physical regions, forging partnerships with stakeholders from firms, public agencies, universities, institutes and having them collaborate to implement innovations in their region. Through this approach, partners will be enabled to take the next step towards climate-smart farming.

"Partners will be enabled to take the next step towards climate-smart farming"

Rik Eweg
Professor Sustainable Agribusiness in Metropolitan Areas
Van Hall Larenstein University of Applied Sciences

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