Practice briefs

Inclusive and climate smart business models in Ethiopian and Kenyan dairy value chains (CSDEK)

2019-2020

Written in collaboration with the professorships **Climate Smart Dairy Value Chains** and **Sustainable Agribusiness in Metropolitan Areas**.

van hall larenstein
university of applied sciences

www.hvhl.nl

This work has been implemented as part of the professorships Climate Smart Dairy Value Chains (CSDVC) and Sustainable Agribusiness in Metropolitan Areas (SAMA). It was supported through student theses research of the Master Agricultural Production Chain Management (APCM), the Master Management of Development (MOD) and the Bachelor International Development Management (IDM) of Van Hall Larenstein University of Applied Sciences, see https:// www.vhluniversity.com/research or https:// www.vhluniversity.com/study.

This document has been made possible with support from the Dutch Research Council (NWO), the Government of the Netherlands, Climate Change Agriculture and Food Security (CCFAS) programme of GCIAR and the 'Samenwerkingsverband Noord-Nederland' (SNN), through the education programme of the Dairy Campus project. The contents are the responsibility of the producing organization and do not necessarily reflect the opinion of NWO, CCAFS, SNN, Dairy Campus or the NL Government.

Editing, design and layout - Van Hall Larenstein / marketing and communication, Leeuwarden/Velp, The Netherlands.
Cover photo - VHL staff (Robert Baars)
ISBN/EAN: 9789083062822
DOI: 10.31715/2020.2

Citation:
Baars, R.M.T. and Verschuur, C.M. (eds.). 2020. Inclusive and climate smart business models in Ethiopian and Kenyan dairy value chains. Practice briefs 2019-2020. Velp, the Netherlands: Van Hall Larenstein University of Applied Sciences.

Citation practice brief (example):
Godadaw Misganaw, Biruh Tesfahun, Sara Hailemariam, Demeke Haile, Robert Baars and Marco Verschuur. 2019. Dairy value chain map in Ziway-Hawassa milk shed, Ethiopia. Practice Brief CSDEK Project 2019-01. In: Baars, R.M.T. and Verschuur, C.M. (eds.). 2020. Inclusive and climate smart business models in Ethiopian and Kenyan dairy value chains. Practice briefs 2019-2020. Velp, the Netherlands: Van Hall Larenstein University of Applied Sciences.

Foreword

This booklet presents sixteen “practice briefs” which are popular publications based on 12 Master and one Bachelor theses of Van Hall Larenstein University of Applied Sciences (VHL). All theses were commissioned through the research project entitled “Inclusive and climate smart business models in Ethiopian and Kenyan dairy value chains (CSDEK)”. The objective of this research is 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 CSDEK project is part of a programme in which three international organisations collaborate: 1. The Dutch Organisation for Scientific Research (NWO) through the Global Challenges Programme; 2. The (Dutch) Food and Business Knowledge Platform (F&BKP); 3. the Climate Change Agriculture and Food Security (CCAFS) programme of CGIAR.

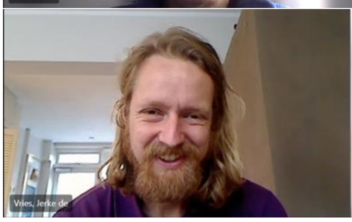
The project started January 2018 and will end December 2020 and is implemented by VHL (The Netherlands), Jimma University (Ethiopia), USIU and Moi University (Kenya), MSU (USA) and AgriProFocus together with UNIQUE land-use (Germany). The publications in this booklet are only those commissioned by VHL and implemented by VHL students and staff.

The CSDEK project selected 6 case study areas, 3 in Ethiopia and 3 in Kenya. This booklet reflects the case study of the Ziway-Hawassa milk shed in Ethiopia and the case study of Githunguri Dairy Farmers Cooperative Society in Kiambu, Kenya.
The project team and researchers hope to make a contribution to the climate smart development of the dairy sector in Ethiopia and Kenya. We hope you will appreciate the efforts reported in this booklet.

- *Robert Baars (Project leader CSDEK), Professor Climate Smart Dairy Value Chains (contact for further information: robert.baars@hvhl.nl)*
- *Marco Verschuur (PhD fellow CSDEK), Senior Lecturer Dairy Value Chains*
- *Rik Eweg (Project member CSDEK), Professor Sustainable Agribusiness in Metropolitan Areas*
- *Jerke de Vries (Project advisor CSDEK), Associate Professor Environmental Impact Circular Agro-Food Chains*
- *Johan Meinderts (Project manager CSDEK), Senior Lecturer Dairy Husbandry*

November 2020




List of content

Practice briefs Ethiopia:

Practice briefs Kenya:

Dairy value chain map in Ziway-Hawassa milk shed, Ethiopia

Godadaw Misganaw, Biruh Tesfahun, Sara Hailemariam, Demeke Haile, Robert Baars, Marco Verschuur,

Practice Brief
CSDEK Project 2019-01

CSDEK = Inclusive and climate smart business models in Ethiopian and Kenyan dairy value chains

The value chain map (Figure 5) shows chain actors and supporters as well as the flow of payment and products in the chain. The identified stages of the milk chain are input supplying, production, collection and processing, retailing and consumption.

Figure 1. *Crossbred dairy cows at a dairy farm in Ziway.*

Farmers' input supply

Milk producers are peri-urban and urban smallholder dairy farmers. Input supplied are feeds, forage seeds, medicines, improved breed, AI services and advisory services. Crossbred dairy cattle are provided by Gobe private dairy farm and by Adami Tulu Agricultural Research Centre (Demeke, 2018). AI services are provided by the Livestock and Fisheries Office.

Fifteen types of feed resources were identified in the milk shed (Sarah Hailemariam, 2018). Urban dairy farmers are more than per-urban using purchased concentrates, crop residues and green forages. High energy diets are also provided more in urban farming than peri-urban farming. Neither urban nor peri-urban farmers are in a strong position to produce animal feed. From the sampled respondents, only 3% of the farmers cultivated improved forage (Sara Hailemariam, 2018).

Figure 2. *Farmers feed storage at Ziway.*

Alema Koudijs (AK) provides balanced ration feeds for dairy, poultry and beef animals. AK provides three types of rations: basic, excellent and super. Retail agents supply feed for AK and buy directly from the company. AK agents responded that unavailability and high price of raw material made the price high for dairy producers. The agents provide brochures on how to feed the milking cow, heifer, calf and dry cow. Each agent has 10-20 producers regularly purchasing feed (Demeke, 2018).

Private drug suppliers provide different types of drugs to small-scale farmers, large-scale farmers, cooperatives and experts, and some of them give door-to-door health services. They give advice about the application and offer antibiotics, anthelmintics, vitamins and calcium. Unlicensed drug suppliers exist too and expired drugs would be sold to the producers through them (Demeke, 2018).

Milk sourcing and distribution channels

Thirty-two milk collection points and four processing units were identified In Ziway-Hawassa milk shed (Figure 3) (Godadaw, 2018). Most of the collection points are located at Shashemene town, likely a result of the availability of a high number of consumers and the ideal location of the city between the major milk production areas in Arsi-Negele and Kofele districts. There are no milk processing units in Kofele and Dugda Districts.

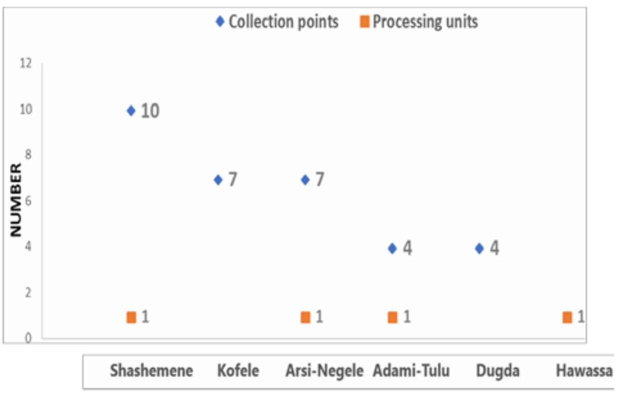


Figure 3. *Identified milk collection and processing units in Ziway-Hawassa milk shed.*

Almost all collection points collect milk directly from urban and peri-urban milk producers. Only 3% of the collectors purchased milk from other milk collectors besides producers. Collecting from the same sources lead to unhealthy competition among collectors and could be a cause for high fluctuation of the purchasing price of milk. Therefore, instead of paying attention to quality, everyone cares about quantity.

Milk is transported from producers to collectors and or consumers by carts (Figure 4), on foot or via public transport and private transportation trucks. Except for a few large volume collectors that use their own milk transportation truck, the Bajaj (small three-wheel vehicle) was mainly used for collection of milk within the town. Some respondents (33%) also indicated that a mixed transportation system (public transport from one area, on-foot from another area and or private truck from somewhere) was used for milk collection (Godadaw, 2018).

Figure 4. *Mules transportation of milk.*

As indicated in Figure 5, the downstream chain actors have multiple roles. Collectors have their own retailing outlets that link them to the consumers and they also sell milk to retailers. The overlays shown in the chain in Figure 5 are milk purchasing and selling prices. Large-scale collectors purchase and sell with relatively low prices compared to small-scale collectors. As milk processors also produce milk on their own farms, they perform milk producing to retailing functions and they use the same purchasing prices as large-scale collectors.

Within the town, Bajaj's are used for distribution of milk to consumers and or retailers which are located at a somewhat far distance and require a relatively large volume of milk per day. Large volume collectors mainly use their own transportation truck for distribution of milk to institutional consumers such as prisoner's corrective institution, health centres and some known hotels and restaurants. Fifty-five percent of the milk collectors distribute milk on-foot to the consumers (Godadaw, 2018). Because most collection points are near high population density sites, milk can be purchased throughout the day. Therefore, because of the proximity of consumers, on-foot distribution is most effective and profitable.

The purchaser is responsible for the transportation of milk from collection point to his home or institute in the Ziway-Hawassa milk shed. However, collection centres are responsible for the delivery and transportation of milk purchased to some big hotels and institutes, mainly through contract agreements.

References

Biruh Tezera. 2018. Carbon Footprint of Milk at Smallholder Dairy Production in Ziway- Hawassa Milk Shade, Ethiopia. Thesis APCM. Thesis Master Agricultural Production Chain Management.

Demeke Haile Engidashet. 2018. Supporters Services And Private Sector To Scale Up Climate-Smart Dairy In Ziway-Hawassa Milk Shed, Ethiopia. Thesis Master Agricultural Production Chain Management.

Godadaw Misganaw Demlew. 2018. Identification of Climate-Smart Practices in the Downstream Dairy Value Chain in Ziway-Hawassa Milk Shed, Ethiopia. Thesis Master Agricultural Production Chain Management.

Sara Hailemariam. 2018. Opportunities for Scaling Up Climate Smart Dairy Production in Ziway-Hawassa Milk Shed, Ethiopia.
Thesis Master Agricultural Production Chain Management.

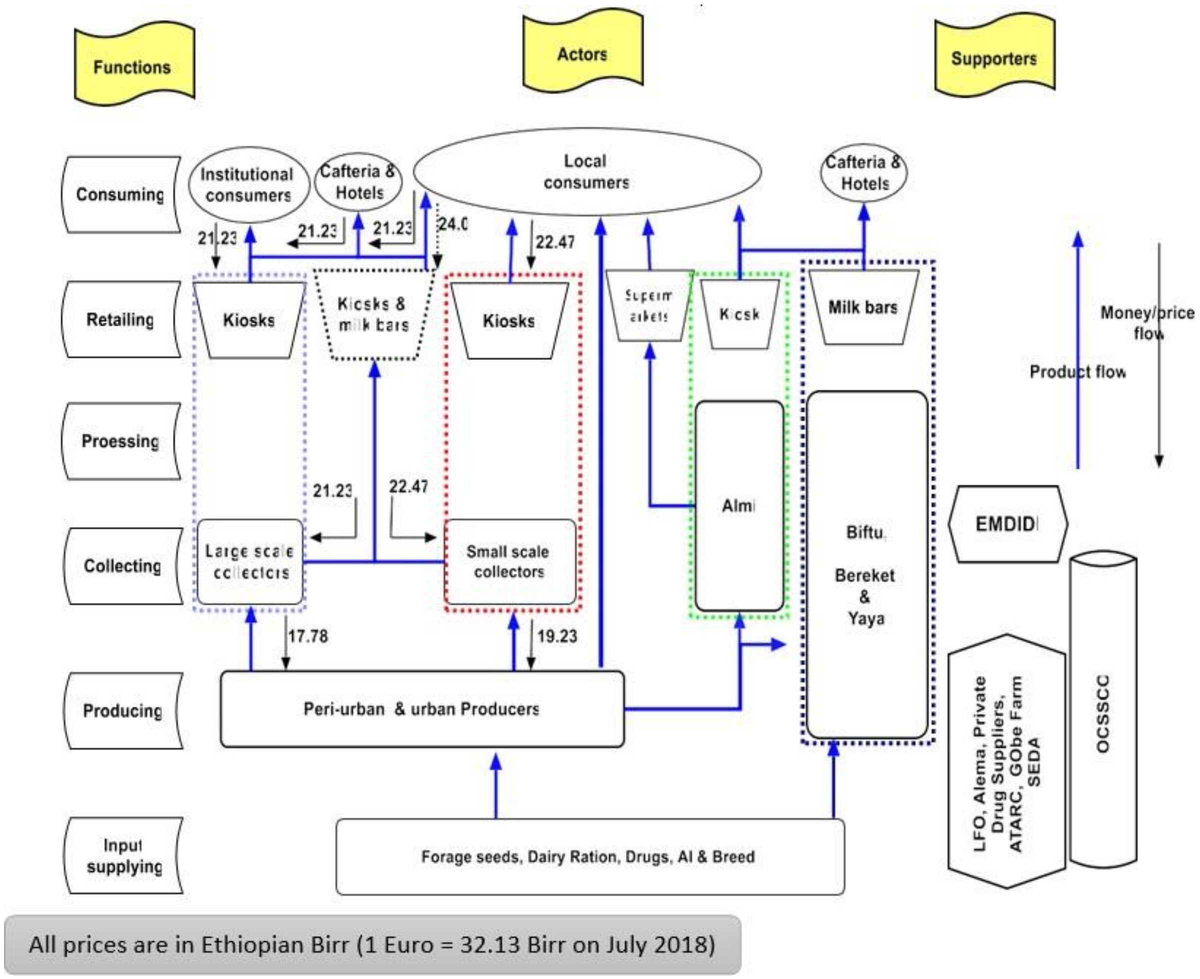


Figure 5. *Dairy value chain map with chain actors and chain supporters in the Ziway-Hawassa milk shed.*

Supporter services and private sector to scale up climate smart dairy in Ziway-Hawassa milk shed, Ethiopia

Demeke Haile, Robert Baars, Marco Verschuur, Biruh Tesfahun, Sara Hailemariam, Godadaw Misganaw

Practice Brief
CSDEK Project 2019-02

CSDEK = Inclusive and climate smart business models in Ethiopian and Kenyan dairy value chains

The Ziway-Hawassa milk shed has untapped opportunities to supply milk and milk products to towns and cities. The small private and cooperative processing facilities so far can collect, process and market limited volumes of milk. The government strategy in dairy emphasises intensification of both small- and large-scale farmers.

The objective of this study was to design a business model for the leading supporter to scale-up climate smart practices in the milk shed. There is a lack of information about supporters' roles in the milk shed.

Five districts were selected for this qualitative research (Dugda, Adami Tulu, Arsinegele, Shashemene and Kofele). A total of 24 respondents were interviewed; 12 from government organisations, ten from the private sector and two from NGO's. In addition, two Focus Group Discussions (FGD) were conducted, one at the beginning as an entry point for data collection and one after completion of the fieldwork. The second FGD was held twice in two different locations. The findings of the developed business model were discussed and improved.

***Table 1.** Persons interviewed*

Organisations of interviewees	Position of Interviewee	No.
Adami Tulu Agricultural Research Centre (ATARC)	Experts	2
Hawassa University (HU)	Head Animal and Range Sciences	1
Livestock and Fishery Office (LFO)	Dairy expert	5
Oromia Credit and Saving Share Company (OCSSCO)	Director	4
Alema Koudijs	Agent	5
Drug suppliers	Manager	5
Sustainable Environment Development Action (SEDA)	Expert	2
	Total	24

Supporters and their services

The supporter institutions were categorised into government organisations, private sector and non-governmental organisations. The private sector is actually a chain actor but considered as a supporter in this brief.

Government organisations involved in supporting dairy value chain in the milk shed were Livestock and Fishery Office (LFO), Adami Tulu Agricultural Research Centre (ATARC), Oromia Credit and Saving Share Company

(OCSSC), Hawassa University (HU) and Alage ATVET.

Holeta Agricultural Research Centre of the Ethiopian Institute of Agricultural Research (EIAR) serves as the national centre of excellence for dairy research. ATARC is linked to EIAR and provides dairy husbandry training to farmers and Development Agents, sometimes requested by the local government. Farmers are trained before the distribution of forage seeds or heifers/bulls. During 2014-17, 76 subsidised heifers and 20 bulls have been distributed. Model farmers were selected for forage adoption trials. Training on crop residues urea treatment and effective microorganism was given to farmers. ATARC regularly meets with farmer groups in Dugda and Kofele Districts to identify their bottlenecks. ATARC also introduced plastic churner machines to dairy producers.

Figure 1. *Banner Adami Tulu ARC*

HU students are trained in animal science and veterinary medicine at BSc level; dairy technology, animal breeding, animal nutrition and animal production at MSc level; and animal nutrition and animal breeding at PhD level. HU is a source of experts for the district offices, NGO's and the private sector. HU has a research site in the Adami Tulu district, which focuses on feed improvement, but is does not function well. HU also provides training to emerging small volume collectors and processors. Almi processing plant has requested HU to give practical training. HU uses "technology villages" for participatory research, demonstrations, evaluations and scaling-up of technologies.

Alage ATVET is the only agricultural college in the milk shed with the role of teaching students in agricultural related fields including animal science and animal health. The college delivers technically equipped Development Agents (DA's) at diploma level.

LFO provides training to DA's in all districts, advisory services for those engaged in dairy business, and distribution of improved forage plants. Cowpea, Rhodes, Lablab, Desho grass, Elephant grass and Alfalfa were distributed to the farmers. However, only 3% of the farmers are using improved forages. The training was on dairy husbandry practices (feeding, health care, milking, keeping the quality of milk). Artificial insemination service is provided with improved dairy breed semen for an affordable price. Two artificial insemination technicians are available in each district. It is difficult to deliver timely services because the number of kebeles is more than 10. LFO has the mandate to license and inspect private feed suppliers.

OCSSCO has as mission to alleviate poverty in Oromia through making financial services available. OCSSCO is found in all districts except Kofele. It offers a variety of loans: solidarity group-based loans, women entrepreneurs development program loans, general purpose loans, and micro and small enterprise loans. Group members are used as collateral for other members of the group. There are no special loans for dairy farmers. The criteria for a loan are: no bad credit history, letter from the kebele administration, land ownership certificates and valid identification card. Micro and Small Enterprise Loan targets unemployed youth and cooperatives engaged in any profitable business. The microfinance institutions face challenges in collecting loans from farmers, especially when farmers fail to harvest crops. Bunsa Gonofa, Meklit and Metemamen are other available microfinance institutions in the milk shed and engaged in similar services as OCSSCO. Microfinance is the most suitable finance source for smallholder farmers, but the loans are small at small-scale level. Credit gave farmers opportunities to replace their local breed with the cross breed dairy animals, to construct a house and to buy fertiliser (Felleke et al., 2010), or for AI service, purchasing of feed and expanding land areas (Kenduiwa et al., 2016).

Table 2. *Efficiency of supporter services. Data from parallel Practice Briefs*

Suppor-ter	Indicator	Effectiveness
LFO	Aerobic digester composting	Urban 10% use, peri-urban none
	Herd composition Emission Lactation length Number of milking cow Milk yield/household	Urban: 89% cross bred; 2.07 eq CO_2/litre; lactation 8 months; 4 dairy cows; yield 5,504 l/yr Per-urban: 57% cross bred; 4.71 eq CO_2/litre; lactation 7 months; 8 dairy cows; yield 9,260 l/yr
	Forage cultivation	Only a few farmers in peri-urban
ATARC	Forage cultivation	Only a few farmers in peri-urban
	Composite breed	Under research
	Herd composition Emission Lactation length Number of milking cow Milk yield/household	Same as LFO
Alema Koudijs	Milk yield/household	9,260 l/yr urban, 5,504 l/yr peri-urban
Gobe farm	Improved breed Market access	>450 livestock distributed; Nearby farmers have access to market
OCSSCO	Loans provided	Less efficient in peri-urban farmers due to collaterals
Alage ATVET	Practical skills trainer and trainee	Sub-optimal in practical based training
Drug supply	Accessibility	Available in all districts

To develop climate smart dairy, feed processing plants play a vital role. The emission per litre of milk will reduce by providing balanced rations (De Vries et al., 2016). Alema Koudijs (AK) provides balanced ration feeds for dairy, poultry and beef animals. AK provides three types of rations: basic, excellent and super. Basic is given to local cows with low milk yields. Excellent and Super are meant for crossbred cows and highest producing cows with more than 15 litres per day. According to respondents, the balanced rations boost the milk yield of the cows. The feed suppliers are retail agents for AK and buy directly from the company. AK agents responded that unavailability and high price of raw material made the price expensive for dairy producers. In general, the price of balanced ration was expensive and unaffordable for smallholder farmers (Yami et al., 2012). The agents provide brochures on how to feed the milking cow, heifer, calf and dry cow. The brochure was prepared in Amharic and English language. It is better if AK prepares the brochure in Oromifa language too! Each agent has 10-20 producers regularly purchasing feed.

Private drug suppliers provide different types of drugs to small-scale farmers, large-scale farmers, cooperatives and experts, and some of them give door-to-door health services. They give advice about the application and offer antibiotics, anthelmintics, vitamins and calcium. One of the suppliers responded to give priority to clients with the prescription of hypocalcaemia. Respondents mentioned that unlicensed drug suppliers exist too and expired drugs would be sold to the producers through them.

Figure 2. *Private drug store*

Gobe Farm is a private dairy farm located in Kofele district. In addition to farming, it sources milk from surrounding farmers and it has been involved in the multiplication and distribution of 50% exotic blood level heifers. Surrounding farmers bought heifers up to 30% discount. 450 pregnant local and cross breed heifers have been distributed in recent years. Farmers pay back the loan by selling milk to Gobe farm. In 2018, Gobe farm collected daily 150-200 litres of milk from the surrounding farmers and transported it to their selling outlets in Shashemene and Kofele. In 2018, the farm was largely burnt as a result of political instability in the area.

Sustainable Environment Development Action (SEDA) was the only active NGO in the area, in Dugda and Adami Tulu Districts. SEDA focuses on improved forage development programs. It provides forage plants to model farmers and those having land. During the past five years SNV had been working in the district but the program has phased out. SNV provided plastic milking and transportation materials, which were easy to clean and to transport on a donkey back.

It is concluded that breeding stock, forage development and training were targeted by different types of supporters (Figure 4).

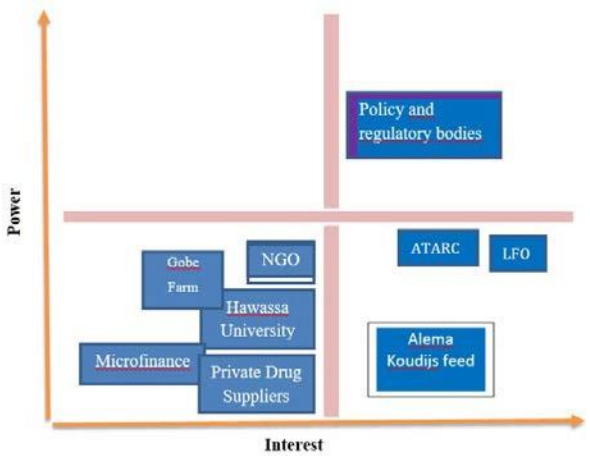


Figure 3. *Power and interest grid of institutions in the dairy sector*

Supporters were placed in the power and interest grid (Figure 3) depending on the power impact of the service they provide and their interest to support the chain. ATARC, LFO Alema Koudijs and policy and regulatory bodies are considered as high interest supporters, whereas the last one also as a high power supporter.

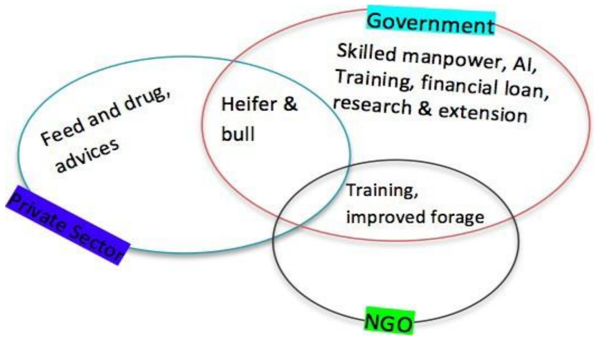


Figure 4. *Supporters service per cluster*

Policy frameworks

The *Ethiopian constitution* gives freedom for people to move and work in any part of the country without restriction. This right allows domestic investors from other parts of the country to invest in the milk shed but this is hardly done due to the continuous tense political situation.

The *Investment Policy* allows domestic and foreign investors to invest in the country. The dairy and animal feed sectors are invested by foreign and domestic investors. The foreign investor can run the business alone or in a joint venture. The investment policy provides a tax exemption for the dairy sector of three to four years. Thanks to an encouraging investment policy, a new milk processing plant is under construction in Adami Tulu District, and a new feed processing plant (Alito) has been established in Hawassa. Capital required by foreign investors was reduced from 500,000 to 100,000 dollars, which encourages investors to invest in the milk shed (Nell, 2006).

The *Cooperative Proclamation* was approved in 1998. According to the respondents, the approval of the proclamation gave an opportunity for the development of dairy cooperatives (Biftu in Shashemene). The proclamation gives the cooperative power to produce, collect and process milk. It also gives the opportunity to establish microfinance institutions. In the milk shed only Biftu cooperative in Shashemene was involved in the dairy business (Brandsma et al., 2013).

Animal health clinics were constructed at kebele level through the *Agriculture Growth Program II* to strengthen animal disease prevention and control. In addition, motorcycles were distributed to artificial inseminators. The cross breed cattle proportion increased in the AGP I period (2010-2015) from 10.37% to 14.53% (FDRE 2016). AGP II is working with ATARC and FLO in the animal healthcare and breed improvement programs by providing financial and logistic support (MoE 2015).

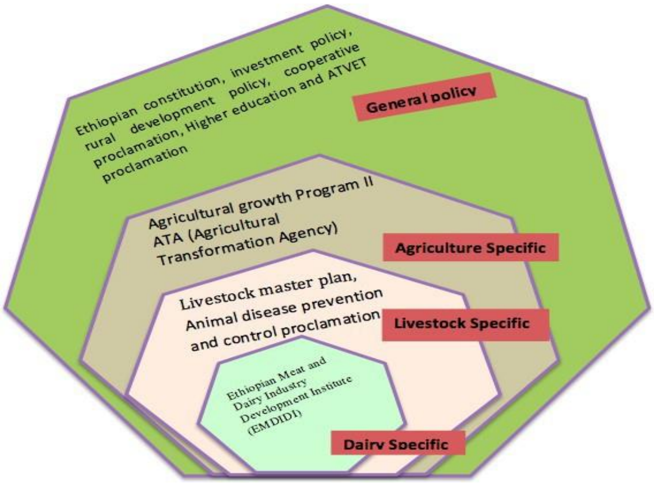


Figure 5. *Policies and proclamations*

The *Animal Disease Prevention and Control Proclamation* was established to prevent the occurrence of disease and disease outbreaks. LFO is implementing vaccination campaigns. The respondents confirmed that the government was providing drugs and vaccines.

The *Livestock Master Plan* in the dairy sector has the vision to become self-sufficient in milk and milk products, the per capita consumption to reach world average in 2025. The master plan states that improved dairy cattle would increase from 10.3% to 42.3% in 2025 and the milk yield will increase in cross breed cows from 1.5 to 8 litres. The plan looks good but seems unrealistic. Breed improvement is key to decrease the emission released per litre of milk.

Higher Education and ATVET Proclamation. The government of Ethiopia rapidly expands its higher education institutions in the country. The number of government universities in the country is more than 30. Universities are knowledge banks of experts for the private sector, NGO's and government organisations at different levels. Students graduate in BSc, MSc and PhD levels in different disciplines, whereas ATVETs provide diploma programmes, key to human resources in the extension service at kebele level.

Ethiopian Meat and Dairy Industry Development Institute (EMDIDI) has the mandate to ensure that dairy products meet quality standards, and to develop a marketing system based on quality. In addition, EMDIDI assists in capacity building of producers, collectors and processors, as confirmed by respondents.

Innovation platforms

Informal chains and local breeds dominate the Ziway-Hawassa milk shed and the speed of innovations is low, despite the efforts of universities, Alage ATVET, LFO, ATARC, Alema Koudijs and their agents, drug suppliers and SEDA.

LFO is the main responsible body to provide services in the dairy sector. The office is the source of information in the dairy sector in all districts. Three development agents (DA's) are assigned in each kebele for extension services to farmers. The DA's make use of farmer training centres, farmer research groups, and farmers field days. There are one to five development teams in each kebele. A team is led by a model farmers (using or willing to adopt new technology). LFO monitors and evaluates the services provided to farmers. LFO respondents mentioned the low motivation among farmers to adopt new technologies. The farmer training centre was used to demonstrate on-farm experiments so that farmers could observed it and put it into practice. During field days, farmers learn from each other, i.e. some farmers' may be best in feed production or conservation and the other in dairy cow management. The knowledge sharing among farmers was created in the field day programs.

Research and capacity building in dairy is a local, national and international responsibility. Alage ATVET trains students for three years in diploma programs in animal sciences and animal health. Hawassa University offers dairy technology at master level and conducted research in dairy and forage improvement. Additionally, they provide training for producers, collectors and processors. However, research and training are insufficiently demand driven. The extension services provided by HU is limited. ATARC identifies problems through farmer research group and prioritised them to find solutions. ATARC provides AI services, training, heifer and bull distribution and extension service. The centre has an extension service to provide new technology, newly released findings and to adopt technologies. However, there is limited logistic to provide the service to the smallholder farmers. Farmer research groups were found in only two districts (Dugda and Kofele) that were used as entry point to ATARC. Farmers research group also creates room to convince non-participating farmers to participate in the approach (Worku, 2017).

Private service providers have limited interaction with the research and education centres for acquiring inputs (genetically improved heifer and bull) and new knowledge through training. The research and education centres have limited capacity to provide inputs to the private supporters.

SEDA has interaction with LFO in providing services. LFO identifies producers with the help of DA's in the interest of the service providers. SEDA works with LFO by providing capacity development training for staff and DA's.

Business model

The Canvas Business Models was developed for the leading supportive organisation, the Livestock and Fisheries Office (Figure 6). The text in red font in the model concerns suggested additions by the authors of this brief to scale-up climate smart dairy practices.

Highlights

- Several organisations focus on improved forage seed distribution, dairy husbandry training, heifers and bulls distribution and AI services, but their impact is limited.
- The private sector sells drugs, feed and cross bred livestock to the community. Access is sufficient although prices restrict farmers from making use of it.
- The policy environment is conducive.
- There are several innovation platforms but they are not very effective. There is more interaction needed between the different platforms.

Recommendations for Livestock and Fishery Office

- Improve practical skills and capacity building of DA's through effective collaboration with EMDIDI, ATARC and Hawassa University.
- Intensify training of AI technicians and selected farmers from the community; increase collaboration with the national artificial insemination centre; privatise AI services.
- Ministry of Agriculture and Livestock Resources: support existing private or government heifer multiplication ranches.
- Organise regular workshops to discuss and share ideas between producers, collectors and processors. Include awareness creation on climate smart dairy.
- Conduct field days across districts. Farmers in one district share their practices with other districts.
- Prepare training manuals in forage production, herd management, heat detection in the local language that helps the farmers to understand easily. Make use of existing training packages (e.g. from SNV).
- Using mass media FM radio programs weekly or once in two weeks as a learning platform.

References

Brandsma, W., Mengistu, D., Kassa, B., Yohannes, M., Lee, J., 2013. The Major Ethiopian Milksheds: An Assessment of Development Potential. [pdf] Available at: <http://edepot.wur.nl/341410> [Accessed 28 April 2018].

De Vries, M., Yigrem, S. and Vellinga, T., 2016. Greening of Ethiopian Dairy Value Chains: Evaluation of environmental impacts and identification of interventions for sustainable intensification of dairy value chains. [Pdf] Available at:

<https://library.wur.nl/WebQuery/wurpubs/fulltext/408614> [Access 1 September 2018].

FDRE, 2016. The Second Growth and Transformation Plan (GTP II). [Pdf] <http://www.aarc.gov.et/images/demo1/Ethiopia%20%20Growth%20and%20Transformation%20Plan%20II.pdf> [Access 3 September 2018].

Felleke, G., Woldearegay, M. and Haile, G., 2010. Inventory of Dairy Policy Ethiopia. [Pdf] Available at: <http://targetethiopia.com/wp-content/uploads/2018/01/DVC-Dairy-Policy-Inventory-2009.pdf> [Access 3 September 2018].

Kenduiwa, A.A., Mwonya. A.R. and Kinuthia, N.L., 2016. Influence of Smallholder Dairy Farmers' Participation in Microfinance on Breed Improvement in Dairy Farming in Longisa Sub-County, Bomet County, Kenya. *Journal of Agriculture and Veterinary Science.* 9, 66-75.

MoE, 2015. Agricultural Growth Program II (AGP-II) Program Design Document. [Pdf] Available at: <http://webcache.googleusercontent.com/search?q=cache:FMe4CR4WLWoJ:eeas.europa.eu/archives/delegations/ethiopia/documents/financing_agreement/1._agp_ii_design_doc.docx+&cd=1&hl=en&ct=clnk&gl=nl>[Access 1 September 2018].

Nell, A.J., 2006. Quick Scan of the Livestock and Meat Sector in Ethiopia. [Pdf]. Available at: <https://edepot.wur.nl/22877> [Access 30 August 2018].

Worku, A.A., 2017. The Effectiveness of Farmers Research Group Approach in Potato Technology Dissemination And Adoption Case Study of Western Part of Ethiopia. International Journal of Agricultural Extension. 5, 43-49.

Yami, M., Begna, B., Teklewold, T., Lemma, E., Etana, T. Legese, G. and Duncan, A.J., 2012. Analysis of the Dairy Value Chain in Lemu-Bilbilo District in the Arsi Highlands of Ethiopia. [Pdf] Available at: <https://cgspace.cgiar.org/bitstream/handle/10568/33511/quickfeedsvca_kulumsa.pdf?sequence=2&isAllowed=y> [Access 1 September 2018].

<table>
<tr>
<td rowspan="2">Key Partners
• Sustainable Environment Development Agent (SEDA)
• OCSSCO
• Adami Tulu Agricultural Research Centre
• Hawassa University
• Cooperative Office
• Energy and Mining Office
• Ethiopian Meat and Dairy Industry Development Institute (EMDIDI)
• International Livestock Research Institute (ILRI)</td>
<td>Key Activities
• Training and extension
• Improved forage development and distribution
• Artificial insemination services
• Organise workshops
• Manual preparation in local language</td>
<td rowspan="2">Value Proposition
• Knowledge support
• Input delivery (AI, seed, feed, drug, medication)
• Mass artificial insemination</td>
<td>Customer Relationships
• Loyalty
• Impartial service provision
• Commitment
• Supervision</td>
<td rowspan="2">Customer Segments
• Small-scale farmers
• Medium- and large-scale farmer
• Private feed supplier
• Private drug supplier
• Farmers trained as AI agent
• Dairy cooperatives
• Milk collector
• Milk processor
• Retailers</td>
</tr>
<tr>
<td>Key Resources
• Development agents
• Microfinance
• Farmer training centre
• Farmer research groups
• ICT</td>
<td>Channels
• Personal interaction with the farmers
• Farmers day
• Farmer training centre
• Farmer research group
• Monitoring and evaluation
• Website/Facebook platform
• Mass media like FM Radio</td>
</tr>
<tr>
<td colspan="2">Cost Structure
• Transport, cost of inputs, maintenance cost and salary</td>
<td colspan="3">Revenue Streams
• Government budget
• Service fee (AI and Medication)</td>
</tr>
<tr>
<td colspan="2">Social and environmental cost
• Emission through transportation</td>
<td colspan="3">Social and environmental benefit
• Awareness creation</td>
</tr>
</table>

Figure 6. *Canvas Business Model of the Livestock and Fisheries Office. Text in red are not practised but suggestions of authors.*

Carbon footprint in the downstream dairy value chain in the Ziway-Hawassa milk shed, Ethiopia

Godadaw Misganaw, Robert Baars, Marco Verschuur, Biruh Tesfahun, Sara Hailemariam, Demeke Haile

Practice Brief
CSDEK Project 2019-03

CSDEK = Inclusive and climate smart business models in Ethiopian and Kenyan dairy value chains

Ethiopia has the ambition to reduce net Greenhouse Gas (GHG) emissions and improve resilience to climate change towards 2030 (FDRE, 2011). In 2013, the dairy cattle sector in Ethiopia emitted 116.3 million tonnes carbon dioxide equivalent (CO_2-eq) (FAO and NZAGRC, 2017). Even though the production of raw milk contributes more than 80% of the GHG emissions, the subsequent process (raw milk collection, product processing and distribution to consumers) has also non-negligible impact on climate change (Guercia et al., 2016).

Analysis of the dairy supply chain is necessary to provide the dairy industry with a documented baseline of the carbon footprint of fluid milk for one's country (Thomas et al., 2013). The objective of this study was to estimate carbon footprint of milk collection and processing of downstream dairy chain actors in the Ziway-Hawassa milk shed.

Approach

Carbon footprint was estimated for milk collection and dairy processing plants. A survey was conducted among 28 small- and large-scale milk collectors and four employees of processing plants in the Mid-Rift Valley of Ethiopia. Additional observations were carried out using recording sheets for machines' power consumption and electricity bills. Those who collected more than 150 kg milk per day were considered large-scale collectors (N=13), and the remaining as small-scale collectors (N=15). Life cycle analysis was used to evaluate the possible environmental impact of a product throughout its life cycle based on GHG emissions energy (Huysveld et al., 2015). There were two main sources of GHGs at factory level, process energy consumption and fossil fuel consumption for transport. The post-farm gate emissions occurred through transportation, cooling and processing systems.

Standard emission factors were converted to CO_2 emissions. Emission factors for diesel and gasoline cars in Ethiopia were 2.67 and 2.42 CO_2-eq/l respectively (Gebre, 2016), and for electricity 0.13 kg CO_2/kWh (Brander et al., 2011).

Milk transportation

Milk collectors emit GHG through transport and cooling machines. Transport is used in two phases along the milk supply chain (Figure 1). The first one is used to collect raw milk from producers to collection points and or processing plants (transportation 1), whereas the second for distribution from collection points to retailers and or consumers (transportation 2).

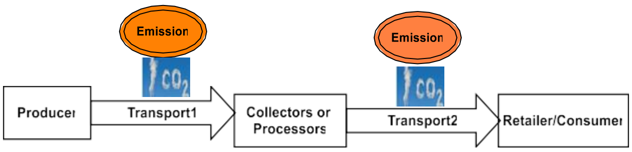


Figure 1. *Supply chain of milk in the shed.*

To estimate the carbon footprint of milk in the transportation phase the following elements were considered: Types of public or private transport used, kilometres travelled, the quantity of milk transported, fuel consumption by the vehicle per kilometre and its capacity of loading.

In the Ziway-Hawassa milk shed, mainly minibuses and three-wheelers (Bajaj's) were used for collection and distribution of milk (Table 1). Chilled transportation was not reported in the shed. Some milk collectors had their own minibus that was used for milk transportation after having removed the chair (the so-called milk car), whereas others used public transport minibuses.

Table 1. *Transport utilization (%) by small- and large-scale milk collectors.*

Transport type	Large-scale		Small-scale	
	N	Loading efficiency (%)	N	Loading efficiency (%)
Milk car	8	30	4	9
Bajaj	5	74	10	10
Motorbike			1	72

To reduce carbon footprint per kg milk, it is required to efficiently utilize vehicles' loading capacity**.** Only vehicles having milk transportation as main use for were considered to estimate utilization efficiency. Thus, vehicles used for transportation of milk with public transport or other items were not included in this efficiency estimation. Few collectors used the full loading capacity of the vehicles during milk collection and distribution. Large-scale collectors utilised milk cars up to 30% of their loading capacity, and this was only 9% for small-scale collectors (Table 1).

Annually, a total of 2.4 million (out of 2.9 million) kg of milk was collected by emission-based transportation (transportation 1), the remaining being emission-free collection. In the milk distribution phase (transportation 2), annually 1.3 million (out of 2.9 million) kg of milk was distributed through emission-based means of transportation. The milk distributed through emission-free means of transportation was higher than emission-based in "transportation 2".

Milk cooling and processing

Cooling facilities also contributed to carbon footprint through power utilization. Milk collection points only used electric sources for their power requirement, no one reported a generator.

Emissions were estimated by using the energy consumption data of the equipment. The following were considered: electricity use for cooling, processing and packaging of milk. Energy consumption of cooling and processing machines was collected from electricity bills and or equipment specification (kWh).

Table 2. *The utilisation efficiency of refrigerators used by milk collectors.*

Capacity (no. fridges)	N	Efficiency (%)
	Large-scale collectors	
250 kg (3)	3	44
500 kg (23)	5	50
2000 kg (2)	2	45
Average		48.5
	Small-scale collectors	
250 kg (12)	10	11
500 kg (3)	3	6
Average		9.3

Efficient utilisation of cooling machines can reduce carbon footprint per kg milk. Most large-scale collectors used a relatively high number of medium-sized refrigerators. Large-scale collectors utilised their cooling machines up to 48.5% of its holding capacity on average (Table 2, Figure 2). However, small-scale collectors preferred and mostly used small capacity refrigerators with the average utilisation efficiency of 9.3%.

Figure 2. *Yaya milk processor and sales shop in Ziway.*

Carbon footprint of milk by collectors

A total of 2,169,440 kg of milk was collected by large-scale collectors for which 20,566 kg of diesel and gasoline fuel was consumed. Small- and large-scale collectors together contributed 79,757 kg CO_2 to the environment per year (Table 3). The mean CO_2-eq/kg milk was 0.021 for large-scale collectors and 0.089 for small-scale collectors ($P<0.05$).

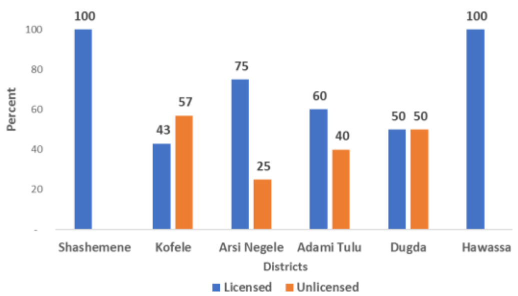


Figure 3. *Proportion of licensed and unlicensed milk collectors and processors in the shed*

The carbon footprint of milk from collectors' cooling machines was estimated through energy consumption (Kwh) utilised per year. The refrigerators of large-scale collectors were used for cooling of 1,228,955 kg of milk throughout the year resulting in a total of 9,915 kg CO_2 to the environment annually (Table 3). Similarly, small-scale collectors contributed 1,547 kg CO_2 to the environment. The mean emission per kg cooled milk was 0.0082 kg CO_2-eq/kg and the same for small- and large-scale collectors.

Table 3. *Carbon footprint of milk at collectors' level.*

	Large-scale (N=13)	Small-scale (N=15)	Both (N=28)
Collection (transport 1)			
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	
Mean (CO_2-eq/kg milk)	0.021	0.089	0.056
Cooling (electricity)			
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	
Mean (CO_2-eq/kg milk)	0.0081	0.0083	0.0082
Distribution (transport 2)			
Milk distributed (l/yr)		1,331,484	
Fuel consumed (l/yr)		31,554	
CO_2 emission (kg/yr)		76,508	
Mean (CO_2-eq/kg milk)			0.060

In Ziway-Hawassa milk shed, milk was mainly distributed by purchasers. However, some collectors were responsible for the transportation and distribution of milk to some customers, especially through vehicles in the case of institutional consumers and large volume retailers. Therefore only 13 collectors were considered for estimation of carbon footprint in the distribution phase (transport 2). On average these collectors released 0.060 CO_2 to the environment.

Carbon footprint of milk by processors

The products processed by all four processors were butter, yoghurt and cottage cheese. The small-scale processors used locally made electrical churner machines (Figure 4) and the cottage cheese was prepared by using firewood.

Figure 4. *Milk churner machine used by small-scale processors.*

Almi fresh milk and milk product processing centre is one of the modern milk processing plants in the shed and processed a relatively large volume of milk per day. The largest proportion of the collected milk was allocated to pasteurised milk and yoghurt. The prices of these two products are affordable and they have a high demand by consumers. Butter and cottage cheese were mainly demanded by institutional consumers like hotels and pizzeria houses. For processing of milk and milk products, Almi utilised 0.610 kWh energy per kg milk from the electric source. As a result, a total of 61,799 kg CO_2 per year was made by this processing plant that is 0.080 kg CO_2-eq/kg milk (Table 4). The other three small-scale processors used relatively low amounts of energy. Initially, they were collectors and retailers of milk, but through time processing started to save unsold milk from spoilage. Bereket, Yaya and Biftu milk processing plants contributed 0.013, 0.014 and 0.010 kg of CO_2-eq/kg milk from electric source respectively.

Except for Biftu, the milk processing plants had a generator as a reserve for electric power interruption. Since Almi fresh milk and milk product processing plant is a relatively big factory, a high-power generator was used that could adequately supply the required power for the machines. Therefore, the generator consumed a huge quantity of fuel and caused an emission of 220,472 kg carbon footprint per year which induced 0.398 kg CO_2-eq/kg processed milk (Table 4). On average milk processors emitted 0.370 kg CO_2-eq/kg processed milk to the environment from fuel source. The average carbon footprint emitted for processing of a kg milk was found to be 0.160 kg from both electric and fuel sources.

Table 4. *Carbon footprint of milk processing from electricity and fuel.*

Processing unit	Power (kWh/year)	CO_2 emitted (kg/year)	Processed milk (kg/year)	CO_2 (kg/kg)
Electricity (Emission factor 0.13 kg CO_2/kWh (Brander et al., 2011))				
Almi	475,373	61,799	774,384	0.080
Bereket	23,407	3,043	238,680	0.013
Yaya	17,358	2,257	159,120	0.014
Biftu	6,987	908	67,704	0.010
Sum	523,124	68,006	1,239,888	**0.055**
Fuel (Emission factors diesel and gasoline 2.67 and 2.42 kg CO_2/kg respectively (Gebre, 2016				
Almi	91,104	220,472	554,216	0.398
Bereket	769	1,860	34,320	0.054
Yaya	2,197	5,316	22,880	0.232
Biftu	-	-	-	-
Sum	94,069	227,648	611,416	**0.370**
Electricity and fuel				
Almi	566,477	282,271	1,328,600	0.210
Bereket	24,176	4,903	273,000	0.020
Yaya	19,555	7,573	182,000	0.042
Biftu	6,987	908	67,704	0.010
Sum	617,193	295,654	1,851,304	**0.160**

Discussion

Small- and large-scale milk collectors in Ziway-Hawassa milk shed contributed through transportation an average emission of 0.056 kg CO_2-eq/kg milk. In the USA a similar level of 0.050 kg CO_2-eq/kg milk was estimated for an average round-trip distance of 850 km (Ulrich et al., 2012). In the same country, a relatively higher (0.070 kg) was reported by Thomas et al. (2013). These figures are lower than the average carbon footprint of 0.089 kg CO_2-eq/kg milk induced by small-scale collectors in the present study, but higher than the 0.021 kg of large-scale collectors. Transport of national branded milk in Italy generated 0.115 kg CO_2-eq/kg milk (Torquati et al., 2015), which is higher than the Ethiopian emissions of this study. A study in Sweden reported an emission of 0.070 kg CO_2-eq/kg milk transported from farm to processing plant (Flysjö, 2012), whereas 0.030 kg was reported in Europe and China (FAO, 2010; Zhao et al., 2017). This is comparable to the average emission contributed by large-scale collectors in the current study (0.021 kg CO_2–eq/kg milk).

In Ziway-Hawassa milk shed, the average CO_2-eq/kg milk emitted by transport from collection points to the retailers/consumers was 0.060 kg. Thomas et al. (2013) reported a slightly higher finding of 0.072 kg CO_2-eq/kg milk for distribution of products from processing plant to retailers/consumers in the USA. However, in China, milk distribution and transportation of packaged milk contributed much lower emissions (0.007 kg CO_2-eq/kg milk) (Zhao et al., 2017).

The average emission released through milk cooling in the present study was 0.008 kg CO_2-eq/kg. In other studies, higher findings have been reported, e.g. from Canada (0.019 kg CO_2-eq/kg fluid milk) (Vergé et al., 2013), and from USA (0.099 kg CO_2-eq/kg refrigerated milk) (Thomas et al., 2013).

In the present study, processors emitted 0.370 and 0.055 kg CO_2-eq/kg processed milk from fuel and electricity respectively. In the USA, emission from processing of products was 0.077 kg CO_2-eq/kg packed milk (Thomas et al., 2013). Studies in Europe reported on average 0.086 (FAO, 2010), and in Sweden 0.05 kg CO_2-eq/kg processed milk (Flysjö, 2012). All these reported values in the USA and Europe are lower than the overall average emission value contributed by milk processors in Ziway-Hawassa milk shed (0.160 kg CO_2-eq/kg milk). Dairy plants in Iran and China emitted on average 0.163 and 0.173 kg CO_2-eq/kg pasteurised milk, respectively (Daneshi et al., 2014; Zhao et al., 2017), which is comparable to this study. In the present study, emission from fuel was much higher than from electricity. In Canada similar findings were reported, 0.666 kg CO_2-eq/kg processed fluid milk from fuel and 0.285 from electricity (Vergé et al. 2013). In fact, the average emission reported in Ziway-Hawassa milk was much lower compared to the findings reported in Canada but higher than the values reported for China (Table 5). In the present study, Almi fresh milk and milk products processing centre showed high emission levels (0.398 CO_2-eq/kg milk) from its fuel generators compared to the other three small-scale processors.

Countries	Carbon footprint (kg CO2/kg milk)				References
	Transport 1	Transport 2	Cooling	Processing	
Ethiopia	0.089	0.060	0.0083		This study
Ethiopia	0.021		0.0081		This study
Ethiopia				0.160	This study
USA	0.050	0.072	0.0990	0.077	Ulrich et al. 2012;
Canada			0.0190	0.285	Vergé et al. 2013
China	0.030	0.007		0.173	Zhao et al. 2017
Europe	0.030			0.086	FAO 2010
Sweden	0.070			0.050	Flysjö 2012
Iran				0.163	Daneshi et al. 2014
Italy	0.115				Torquati et al. 2015

Table 5. *Carbon footprint estimations in the lower dairy value chain in different countries.*

Conclusions

Annually, a total of 2.9 million kg milk was collected by milk collectors and processors. Out of this, 2.4 million kg was collected through different types of motorised transport. The mean kg CO_2-eq/kg milk was significantly different between small- and large-scale milk collectors. On average, milk collectors contributed 0.056 kg CO_2-eq/kg milk during collection (transport 1), 0.060 kg CO_2-eq/kg milk during the distribution of products (transport 2) and 0.008 kg CO_2-eq/kg through cooling machines. Ethiopian large-scale milk collectors showed lower emissions compared to collectors from other countries. Processors in Ziway-Hawassa milk shed contributed emission levels compareable to other countries (0.16 kg CO_2-eq/kg) mainly due to fuel and limited use of electricity. A shift from small- to large-scale milk collection as well as increased use of electricity instead of fossil fuel would result in a lower carbon footprint of the Ethiopian dairy sector.

References

Brander, M., Sood, A., Wylie, C., Haughton, A. and Lovell, J., 2011. *Electricity-specific emission factors for grid electricity*. [PDF] Available at: <https://ecometrica.com/assets/Electricity-specific-emission-factors-for-grid-electricity.pdf> [Accessed 20/4/2018]

Daneshi, A., Esmaili-Sari, A. and Daneshi, M. 2014. Greenhouse gas emissions of packaged fluid milk production in Tehran. *Journal of Cleaner Production,* 3, 1-9.

FAO and NZAGRC, 2017. *Supporting low emissions development in the Ethiopian dairy cattle sector – reducing enteric methane for food security and livelihoods*. Food and Agriculture Organization & New Zealand Agricultural Greenhouse Gas Research Centre. [PDF] Available at: <http://www.fao.org/3/a-i6821e.pdf> [Accessed 4/25/2018]

FAO (Food and Agriculture Organization), 2010. *Greenhouse Gas Emissions from the Dairy Sector—A Life Cycle Assessment.* [PDF]. Rome, Italy. Available at: <http://www.fao.org/docrep/012/k7930e/k7930e00.pdf>. [Accessed on 1/4/2018]

FDRE (Federal Democratic Republic of Ethiopia), 2011. *Ethiopia's Climate-Resilient Green Economy*. [PDF] Available at: <https://www.undp.org/content/dam/ethiopia/docs/Ethiopia%20CRGE.pdf> [Accessed 5/30/2018].

Flysjö, A. 2012. *Greenhouse gas emissions in milk and dairy product chains*. PhD thesis, Aarhus University [PDF] Available at: <http://pure.au.dk/portal/files/45485022/anna_20flusj_.pdf> [Accessed 8/31/18]

Gebre, T., 2016. CO2 Emission Level in Urban Transport of Mekelle City, Ethiopia. *Journal of Environment and Earth Science,* 6, 64-71.

Guercia, M., Proserpio, C., Famigliettic, J., Zanchic, M. and Bilato, G., 2016. *Carbon Footprint of Grana Padano PDO cheese in a full life cycle perspective*. [PDF] Available at: <http://sites.unimi.it/agrifood_lcalab/wp-content/uploads/2016/10/Lca_food_2016_finale.pdf> [Accessed 4/27/2018]

Huysveld, S., Van Linden, V., De Meester, S., Peiren, N., Muylle, H., Lauwers, L., & Dewulf, J., 2015. Resource use assessment of an agricultural system from a life cycle perspective- a dairy farm as case study. *Agricultural Systems*. 135, Pp77-89

Thomas, G., Popp, J., Nutter, D., Shonnard, D., Ulrich, R., Matlock, M., Kim, D.S., Neiderman, Z., Kemper, N., East, C. and Adomd, F., 2013. Greenhouse gas emissions from milk production and consumption in the United States: A cradle-to-grave life cycle assessment. *International Dairy Journal*, 31, 3-14.

Torquati, B., Taglioni, C. and Cavicchi, A., 2015. Evaluating the CO2 Emission of the Milk Supply Chain in Italy: An Exploratory Study. *Sustainability, 7*, 7245-7260.

Ulrich, R., Thomas, G. J., Nutter, D. W., & Wilson, J. 2012. Tailpipe greenhouse gas emissions from tank trucks transporting raw milk from farms to processing plants. *International Dairy Journal*, 31, 50-56.

Vergé, X. P. C., Maxime, D., A. Dyer, J., Desjardins, R. L., Arcand, Y., and Vanderzaag, A. 2013. Carbon footprint of Canadian dairy products: calculations and issues. *Journal of Dairy Science*, 96, 6091–6104.

Zhao, R., Xu, Y., Wen, X., Zhang, N. and Cai J. 2017. Carbon footprint assessment for a local branded pure milk product: a lifecycle-based approach. *Food Science Technology, Campinas*, 38, 98-105.

Key Partners
- EMDIDI
- Livestock and Fishery Office
- Adami-Tulu Agricultural Research Centre
- Hawassa University
- Cooperative Office
- Municipality Office

Key Activities
- Milk collection
- Milk transportation
- Milk distribution

Key Resources
- Collection centre (chilling tank)
- Truck
- Quality testing tools
- Skilled manpower

Value Proposition
- Quantity & quality milk (free from contamination, bad bacteria)

Customer Relationships
- Maintain milk quality
- Fair pricing
- Customer loyalty
- Transparency
- Contract agreement (quality & quantity)

Channels
- Processing centre
- Collection point
- Retailers shop

Customer Segment
- Milk processors
- Local consumers
- Milk retailers
- Institutional consumers

Cost Structure
- Transportation truck (fuel + driver)
- Milk purchasing
- Electric & water charge
- Labor

Revenue Streams
- Milk sale

Social and environmental cost
- Carbon footprint (0.029 kg CO2/litre)

Social and environmental benefit
- Low carbon footprint/ltr of milk (0.041 ⟶0.029)
- Utilization efficiency of vehicles increased
- Utilization efficiency of cooling machine increase (at least from 9% ⟶46%)
- Job opportunity generated
- Environmental safety increase
- Safe milk for consumption, health

Figure 5. *Canvas Business Model of the milk collectors. Text in red are not practised but suggestions of authors.*

Climate smart dairy practices in Ziway-Hawassa milk shed, Ethiopia

Sara Endale Hailemariam, Marco Verschuur, Biruh Tezera, Robert Baars, Rik Eweg, Godadaw Misganaw, Demeke Haile

Practice Brief
CSDEK Project 2019-04

CSDEK = Inclusive and climate smart business models in Ethiopian and Kenyan dairy value chains

The Ziway-Hawassa milk shed has untapped opportunities to supply milk for the area (Brandsma et al., 2013). However, for farmers to invest in climate-smart dairy businesses, there needs to be an attractive and interactive business model which can create value (in the form of revenue or as income diversification, spreading investment risks or reducing stress. So, interventions have to have the potential for improving productivity while at the same time reducing emissions per unit of output.

This study was conducted to investigate dairy farming practices and gross margin at smallholder dairy farmer level to design a business model for scaling up climate-smart dairy in Ziway-Hawassa milk shed.
From five districts (Dugda and Adami Tulu in East-Shoa and Shashimene, Arsi-Negele and Kefole in West-Arsi), 80 sample dairy farmers were selected purposively based on their dairy farming practice. The farmers were categorised as urban and peri-urban dairy farmers. The data was then collected through a survey (structured questionnaire). The collected data were subjected to SPSS and gross margin estimation.

Farming Systems

The primary farming system in urban and peri-urban farming was livestock (72.5%) and mixed production system (72.5%) respectively. For 80.3% of the urban farmers, dairy was the major activity. The main purpose of keeping livestock was for milk production. In peri-urban farming, cattle were also kept for drought power. Manure production and selling were the least purposes in both production systems. The dominant manure management was solid storage and dung for fuel.

The feed resources of the milk shed were categorized as green forage, crop-residue and concentrates. Only 3.3% of the farmers were initiated to produce improved forage. Urban farmers were using more energy-rich concentrates than peri-urban farmers.

The result also revealed that 76% of the urban and 55% of peri-urban farmers depend on milk sales (Figure 1). However, due to the nature of their production system, live animal and crop sales were higher in a peri-urban production system. Even though farmers were not aware of the contribution of cattle to climate change, they were unknowingly practising some climate-smart dairy measures on their farm.

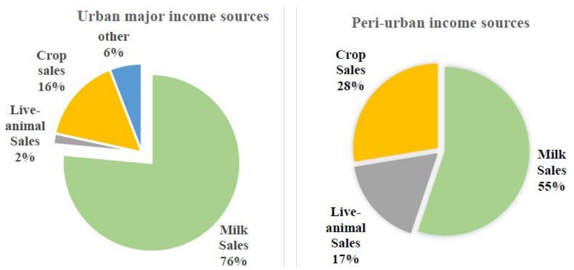


Figure 1. *Income sources of urban and peri-urban dairy farmers*

In urban dairy production, the domination of men in feed selection, feed transportation and selection of cows for insemination was high. However, females, especially wives, were involved in milking, milk processing, milk selling and manure collection. However, females in the peri-urban area had the lead in undertaking dairy activities, such as manure collection from animal barns, milking (Figure 2), feed selection and milk processing at home were. Selecting cows for insemination remains a task performed by men (husbands).

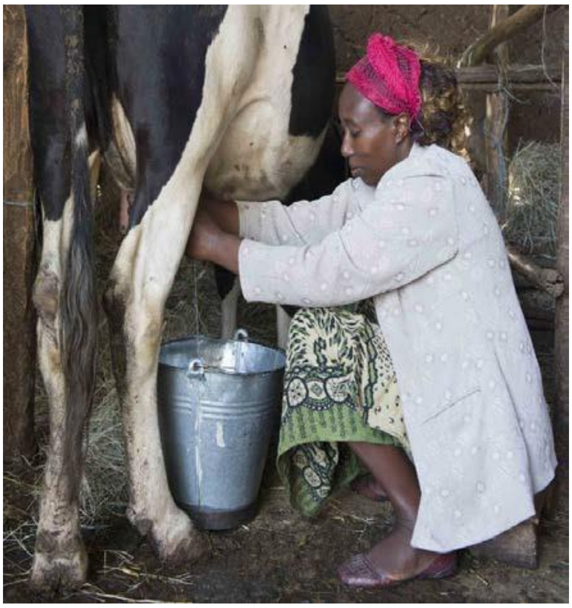


Figure 2. *Woman engaged in milking*

Milk output

The data in table 1 shows the average number of milking cows, milk production, supply and price of milk in urban and peri-urban areas. Peri- urban dairy farmers maintained on average a significantly higher number of milking cows (8.3) than urban dairy farmers (3.6). The urban dairy farmers maintained improved cattle breeds which produced an average of 9260 lts per year, with an average lactation length of 230 days, so 41.0 lts per day. Meanwhile, peri-urban dairy farmers produced 5504 lts per year in 206 days, so 25.8 lts per day. Cows in urban farming produced on average significant higher amount of milk per day (12.1 lts) than in peri-urban farming (6.58 lts).

Table 1 also shows that peri-urban farmers consumed significantly higher volume (5.32 lts) of milk than urban farmers (1.89 lts). On the contrary, urban farmers supplied large volumes of milk per day to the market (39.2 lts) than peri- urban farmers (20.5 lts). However, the milk price was not significant different in both production systems.

As indicated in table 2, the daily milk sales of urban farmers (713 ETB) were significantly higher than peri-urban farmers (362 ETB).

Table 3 explained the cost needed to produce one litre of milk. It shows that urban and peri-urban dairy farmers incurred a total cost of ETB and 17.11 ETB respectively and received different gross margins. On average, urban dairy farmers obtained a higher gross margin per litre milk (1.93 ETB) than peri-urban dairy farmers (0.59 ETB). It also indicated that, urban farmers collected on average over 100% higher yearly revenue than peri-urban farmers of 51262 ETB and 24888 ETB respectively. These resulted in a higher gross margin per farm for urban farmers, 5435 ETB and 830 ETB respectively.

Table 1. Milk output parameters

Variable	Urban (Mean ± SD)	Peri-urban (Mean ± SD)	P-valve
Milking Cows/HH	3.6 ± 2.4	8.3 ± 9.1	.011*
Milk yield /Cow/day	12.01 ± 4.5	6.58 ± 4.2	.000*
Milk yield/ Household/ day	41.0 ± 42.9	25.8± 20.2	.035*
Lactation Length /Cow (month)	7.7 ± 1.5	6.9 ± 1.2	.010*
Milk yield/cow/year	2816.6 ±1246.6	1406.1 ±1018.1	.000*
Milk yield/Year/HH	9260 ± 9021.1	5504±4726	.041*
Home consumed milk/ day	1.89 ± 1.91	5.32 ± 6.14	.006*
Marketable milk/day	39.2 ±42.14	20.5 ± 20.0	.090*
Price of milk	18.2 ± 2.61	17.7 ± 4.60	.580

*significant difference at $p<0.05$

Table 2. Milk sales per farm per day

Farming	Average marketable milk/day (litre)	Average selling price /day (ETB)	Daily total sales (ETB)	P-value
Urban	39.2	18.2	713.4	0.028*
Peri-urban	20.5	17.7	362.8	

*significant difference at $p<0.05$
1Euro=32.13 ETB

Table 3. Production costs

Parameters	Urban Farming	Peri-urban Farming
Average variable cost/liter	16.27	17.11
Average revenue/liter	18.20	17.70
Gross margin/liter	1.93	0.59
Average cost/cow/year	45827.22	24058.37
Average revenue/cow/year	51262.12	24887.97
Gross margin/cow/year	5434.90	829.6
Average cost/farm/year	150660.2	94173.4
Average revenue/farm/year	168532	97420.8
Gross margin/farm/year	17871.8	3247.4

1Euro=32.13 ETB

Climate smart dairy practices

The feeding system of the study area shows that urban dairy farmers were provided high energy diets of good nutritional value. On the contrary, peri-urban farmers majorly depended on locally available crop-residue with small concentrate as a supplement.
Concerning forage, the majority of respondents used local green grass and green maize forage with average feed costs per kg of 3.72 and 1.07 ETB in urban and 2.84 and 0.96 ETB in peri-urban respectively (Table 4). These forages have a good metabolisable energy (ME) and a reasonable crude protein (CP). So, giving these feeds to the cow will enhance the rumen digestibility and consequently take less rumination time and less enteric emission.
Crop residues, such as wheat, teff and barley straw were principally used in both production

systems. These feed types have reasonable ME, but are low in (CP), except for teff straw, which is relative high in ME and very high in CP (table 4). Therefore, teff straw is considered as the most appropriate crop residue, causing the lowest methane gas emission per kilogram of feed offered.

Figure 3. *Teff straw storage*

Urban and peri-urban dairy farmers had a different preference for concentrate feeds. In the urban area (figure 4), farmers used linseed meal, wheat bran, almi mixed ration, atella (local brewery by-product) and brewery by-products (table 4). These feeds have high CP and ME which made a vital feed menu for the dairy animals. However, the purchasing cost of the concentrates shows that wheat bran, atella and brewery by-products were the three least-cost concentrate feed types.

Peri-urban farmers also used concentrate feed but in smaller proportion and number (table 4). Concentrate feeds such as linseed meal, wheat bran, lentil bran, noug and atella have high CP and ME. However, the market price was the limiting factor for farmers. By looking at their ME and relative least cost price, wheat bran, atella (local brewery residue), brewery grain and lentil bran were most economically viable.

Figure 4: Urban dairy farmer

The manure management revealed that climate-smart manure handling such as composting and biogas production was rarely practiced in the milk shed, since most manure is dried and used as dung cake for fuel (figure 5).

The study identified the use of improved crossbreed, high energy feeds, biogas and composting as a climate-smart dairy farming practices of the shed. However, limitations are observed in manure handling, herd size and financial management.
It therefore concluded, that the current business model was not suitable for achieving different climate-smart objectives in terms of its limitation for linking farmers to different partners and activities. It is therefore essential to design a new business model which enhance climate smartness and reduce the cost of production. So, much emphasis is still needed on feeding, manure management and economic efficiency of milk production.

References

Sara Hailemariam. 2018. Opportunities for Scaling Up Climate Smart Dairy Production in Ziway-Hawassa Milk Shed, Ethiopia. Thesis Master Agricultural Production Chain Management, Velp.

Wytze Brandsma, Dawit Mengistu, Binyam Kassa, Mahlet Yohannes and Jan van der Lee, 2012. *The Major Ethiopian Milksheds; Wageningen*, Wageningen UR (University & Research centre) Livestock Research, Livestock Research Report 735, 245 blz.

Table 4: Nutritional value, costs and use of different feeds in urban and peri-urban dairy.

		In kg DM		Feed costs/kg [ETB]		% farmers (n=80) using	
Feed resources	DM (%)	CP (%)	ME [MJ]	urban	peri-urban	urban	peri-urban
Green pasture	31.3	9.8	8.1	3.72	1.07	23.5	31
Maize green forage	23.3	7.9	9.6	2.84	0.96	25.5	27.6
Wheat straw	91.0	4.2	6.8	4.51	2.45	82.4	72.4
Barley straw	90.9	3.8	6.5	3.17	1.67	19.6	48.3
Teff straw	91.7	14.6	7.9	2.55	1.49	33.3	17.2
Almi (dairy) ration	92.3	21		8.6	9.0	51.0	6.8
Lineseed meal/fagullo	90.6	43.1	12.6	10.8	11.2	78.4	48.3
wheat bran - frushka	87	17.3	11	6.6	5.88	84.3	69
Cotton seed meal	90.6	5.1	6.5	11.34	8.34	2.0	10.3
Lentil bran	88.9	19.3	13.5	..	3.45	..	3.5
Noug seed cake	92.2	31.3	11.3	..	4.0	..	6.9
Atella	15.6	20	10	4.6	1	35.3	3.4
Brewers grains	91	25.8	9.9	1.43	2.1	15.7	6.8

Source: Feedipedia (https:/www.feedipedia.org/) and survey data (2018)

Table 5. Manure management systems in urban and peri urban production system

Management	Urban		Peri-urban	
	Farmers (%)	Duration of storage	Farmers (%)	Duration of storage
Anaerobic digester	9.8	12	0.0	0
Burned for fuel	43.1	5.9	72.4	5.9
Composting	2.0	12	3.4	12
Daily spread	0.0	0	3.4	12
Solid storage	88.2	8.3	89.7	5.8

Carbon footprint of smallholder milk production in Ziway-Hawassa milk shed, Ethiopia

Biruh Tesfahun Tezera, Jerke W. de Vries, Marco Verschuur, Sara Endale Hailemariam, Robert Baars, Rik Eweg, Godadaw Misganaw, Demeke Haile

Practice Brief
CSDEK Project 2019-05

CSDEK = Inclusive and climate smart business models in Ethiopian and Kenyan dairy value chains

van hall larenstein
university of applied sciences

Introduction

Milk production is an important contributor to the production of food and the support of livelihoods of smallholder farmers especially in developing countries. Next to contributing to livelihoods, milk production contributes to global warming and climate change through emissions of greenhouse gases (GHGs), mainly methane (CH_4) and nitrous oxide (N_2O). Agriculture as a whole contributes about 11% to the global GHGs with livestock contributing approximately 14.5% to this (Smith et al., 2014). Where CH_4 is mainly emitted through enteric fermentation in the animal gut whereas N_2O emission is mainly related to (de)-nitrification from manure management, from the soil during feed production and pasturing (Chadwick et al., 2011).

Ethiopia is one country in which dairy farms consist mainly of smallholders. More than 63% of the farms are made up of <3 tropical livestock units and can be separated into urban and peri-urban farms (FAO, 2017). Urban farms are located in the urban area whereas peri- urban farms lie in the vicinity of a town. In total there are an estimated 14 million households that keep livestock. Livestock emissions contribute about 65 million tons of CO_2-eq and is estimated to produce up to 124 million tons in 2030 (FDRE, 2011). Henceforth, there is an urgent need to understand the current situation of GHGs from milk production and to develop 'climate smart' farming practices that include different management strategies for reducing greenhouse gases.

Accounting for GHGs of milk has been done by others. On average footprints were between 1 to 7.5 kg of CO_2-eq per kg of fat and protein corrected milk (FPCM) with highest footprints for sub-Saharan production and lowest in industrialized countries (Gerber et al., 2010). Such studies, however, often lack to allocate results to other purposes of keeping livestock, such as traction or draught, dowry and finance functions, typical for smallholder production. Such functions need to be included in carbon footprint assessments in order to represent the multifunctionality of the system and therewith the contextual value of livestock for smallholder livelihoods. If not done so, that is when remaining unallocated or allocated solely to milk, carbon footprints of smallholder milk production will generally be higher compared to specialized large-scale production systems. Weiler et al. (2014) were one of the first to allocate emission to the different purposes of keeping livestock resulting ultimately in similar levels of carbon emissions for smallholders compared to intensive large- scale production in Western countries, i.e. approximately 1.1 kg CO_2-eq per kg of milk for smallholder production when allocated to livelihoods. Hence, the multifunctionality of such systems need to be considered in order to make a representative assessment and target effective mitigation strategies for smallholders.

The aim of this study is to assess the carbon footprint of urban and peri- urban milk production in the Ziwey- Hawassa milk shed in Ethiopia. The assessment was done based on the information collected during a field visit in 2018 in which 80 farmers were visited and interviewed.

Data collection and processing

Data were collected through field surveys in 2018 in the Zewey-Hawassa milk shed and reported in Biruh Tesfahun (2018) and Sara Endale (2018). The shed receives between 500 and 1300 mm of rainfall yearly and temperatures vary from 12 to 27 °C. Crop-livestock farming is the dominant production system in the area and include the production of barley, teff, maize, wheat, sorghum and root crops.

Data were collected based on a structured survey from urban and peri- urban farms and included data on: general farm characteristics, herd size, feed and milk production and consumption and manure management. Data were processed using Excel following the FAO Gold Standard for GHG emission accounting from smallholder dairy farms (FAO & ILRI, 2016). This method uses the life cycle assessment (LCA) methodology to assess the impact throughout the production chain. In addition, the multifunctionality of the production system is considered through three different allocation procedures as described by Weiler et al. (2014): 1. Allocation to food products that allocates according to the output of food products, i.e. milk and meat, 2. Allocation to economically quantifiable products that allocates according to all economically quantifiable products, i.e. milk, meat, manure, traction or draught, finance and insurance and 3. Allocation to livelihood that allocates according to the farmers value of the products for their livelihoods (Figure 1).

Corrections in the dataset were made for feed intake. If dry matter (DM) feed intake exceeded 15 kg DM per cow per day or fresh matter intake exceeded 25 kg per cow per day, datasets were removed from the file. In total 21 datasets were removed. Emissions from on-farm feed production were included. Emissions from external feed production from industrial feedstuffs such as molasses and brewers grain were included based on the Ecoinvent database (EcoinventCentre, 2007). Emissions from dairy ration were included at a rate of 1.36 kg CO_2-eq per kg of ration (Weiler et al., 2014). Emissions for feed transport were included based on the type of transport, the applied distance and emission factor for each type of transportation. Emissions from enteric fermentation and manure management were based on the IPCC guidelines and the gold standard .

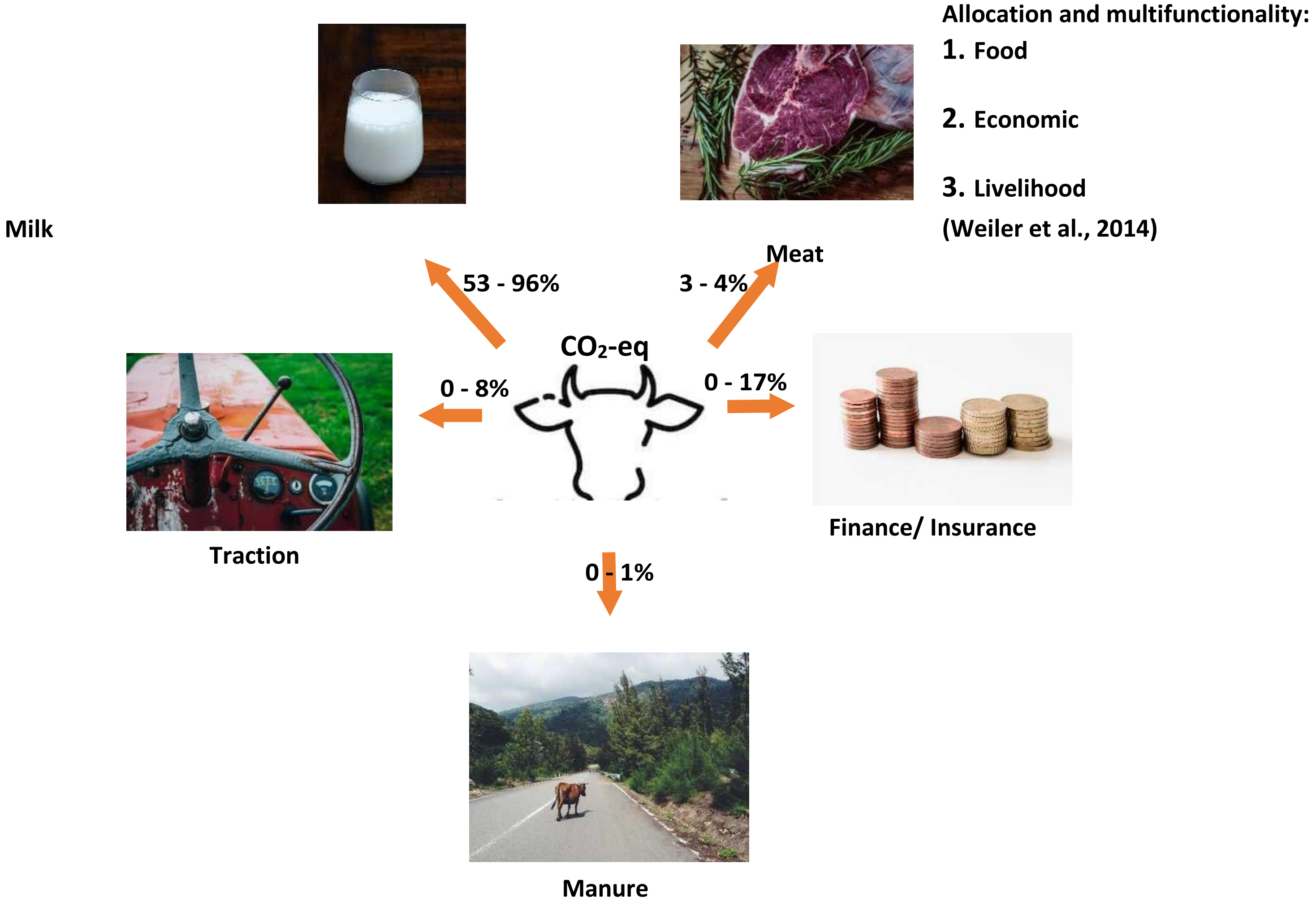


Figure 1. Multifunctionality of milk production and the allocation methods applied in this study. Picture source: unsplash.com.

Outcomes

Overall farm characteristics showed that urban farms have less livestock per farm (on average 8.3 ±6.7 heads) than peri- urban farms (on average 20 ±17 heads). Milk production was approximately 12 liters per cow per day for urban farms and 6.6 liters per cow per day for peri-urban farms. Around 98% of the urban farms supplied their milk to the market whereas this was around 83% for peri-urban farms. For them the majority of the milk produced was consumed at home. Urban and peri-urban farms mainly used green pasture, maize forage, straw, meals and rations as feedstuffs. Both farm types used their manure mainly as fuel and fertilizer for crops. Prior to using the manure, it was stored.

The carbon footprint of smallholder milk production in the Ziwey- Hawassa milk shed ranged between 1.02 and 1.79 kg CO_2-eq per kg of milk for urban production and 3.45 and 6.36 kg CO_2-eq per kg of milk for peri-urban production (Table 1). Footprints varied according to the allocation principle applied reflecting the different values given to the production of milk. In case of food allocation, 96% of the GHGs were allocated to milk whereas for livelihood allocation this was only 57% and 53% for urban and peri-urban, respectively.
Between 89 and 94% of the GHGs

originated from enteric fermentation. 1 to 5% of the GHGs came from feed production, manure management and off farm feed production.

Table 1. Carbon footprint in kg CO_2-eq per kg of milk (min – max range) of urban and peri- urban milk production in the Ziwey-Hawassa milk shed with different allocation methods

Allocation	Urban	Peri-Urban
Unallocated	1.79 (0.35 – 5.72)	6.52 (0.33 – 30.0)
1. Food	1.71	6.28
2. Economic	1.52	4.61
3. Livelihood	1.02	3.45

The footprint of peri-urban farms were in similar order of magnitude as reported, that is between 3.6 and 7 kg CO_2-eq per kg fat and protein corrected milk (Gerber et al., 2010). Urban farms, however, had a lower footprint most likely due to external feed production that was included only for molasses and brewers grains. When including the value for the livelihoods, similar footprints were found compared to milk production in Western Europe (~1.5 kg CO_2-eq per kg of FPCM) and North America (~1.1 kg CO_2-eq per kg of FPCM). Further development in reducing carbon footprints of smallholder farms will aim at improved feeding operations, manure management and milk production. Different management changes can be suggested to reduce carbon footprints, but will have to consider the livelihoods of smallholder farmers.

References

Chadwick, D., Sommer, S., Thorman, R., Fangueiro, D., Cardenas, L., Amon, B., & Misselbrook, T. (2011). Manure management: Implications for greenhouse gas emissions. *Animal Feed Science and Technology*, *166–167*, 514–531. https://doi.org/https://doi.org/10.1016/j.anifeedsci.2011.04.036

EcoinventCentre. (2007). *Ecoinvent Data v2.0 Final Reports Econinvent 2007*. Retrieved from https://www.ecoinvent.org/

Hailemariam, E.S. (2018). Opportunities for Scaling Up Climate Smart Dairy Production in Ziway-Hawassa Milk Shed, Ethiopia. Thesis Master Agricultural Production Chain Management, Velp, the Netherlands.

FAO. (2017). *Africa sustainable livestock country brief Ethiopia*. Retrieved from http://www.fao.org/3/a-i7347e.pdf

FAO & ILRI. (2016). *Smallholder dairy methodology. Draft Methodology for Quantification of GHG Emission Reductions from Improved Management in Smallholder Dairy Production Systems using a Standardized Baseline*. Rome, Italy.

FDRE. (2011). *Ethiopia's Climate-Resilient Green Economy. Green economy strategy*.
Retrieved from https://www.undp.org/content/dam/ethiopia/docs/Ethiopia CRGE.pdf Gerber, P., Vellinga, T., Dietze, K., Falcucci, A., & Gianni, G. (2010). Greenhouse Gas Emissions from the Dairy Sector. *FAO*, 98. https://doi.org/10.1016/S0301- 4215(01)00105-7

Smith, P., Clark, H., Dong, H., Elsiddig, E. A., Haberl, H., Harper, R., … Tubiello, F. (2014).
Chapter 11 - Agriculture, forestry and other land use (AFOLU). Retrieved from http://pure.iiasa.ac.at/id/eprint/11115/#.XL79n_6uyKI.mendeley

Tesfahun Tezera, B. (2018). *Carbon Footprint of Milk at Smallholder Dairy Production in Zeway – Hawassa Milk Shed , Ethiopia*. Thesis Master Agricultural Production Chain Management, Velp, the Netherlands.

Weiler, V., Udo, H. M., Viets, T., Crane, T. A., & De Boer, I. J. (2014). Handling multi- functionality of livestock in a life cycle assessment: the case of smallholder dairying in Kenya. *Current Opinion in Environmental Sustainability*, *8*, 29–38. https://doi.org/10.1016/J.COSUST.2014.07.009

Climate smart dairy practices in Shashamane-Ziway milk shed, Ethiopia

Blessing Mudombi, Marco Verschuur, Robert Baars

Practice Brief
CSDEK Project 2020-01

CSDEK = Inclusive and climate smart business models in Ethiopian and Kenyan dairy value chains

Introduction

Baars, et al. (2019) carried out research in the frame of the NWO-GCP-CCAFS funded 'Climate Smart Dairy in Ethiopia and Kenya' (CSDEK) project on inclusive, resilient climate smart strategies that can be scaled up in the dairy sector in Ethiopia. This research gave an overview of the dairy value chain, the dairy farming systems and the climate smart practices implemented together with the respective GHG emissions for various activities in the value chain. The study gave insights on the different dairy farming systems and gender roles within these farming systems. However, the link between GHG emissions and the profitability of the dairy business, economic and environmental costs that come from each climate smart practice implemented were not established.

Therefore, the aim of the study is to assess the impact of climate smart practices within the dairy farming systems based on the economic and environmental cost and benefits in order to advise on scalable climate smart practices in inclusive and resilient dairy business models.

Methodology

The case study approach was used in this research in order to carry out an in-depth analysis of the dairy farming systems and climate smart practices implemented their effect on profitability and GHG emissions. The study was carried out on 7 case study farms in both urban and peri-urban areas in East Showa and West Arsi region of Oromia in Ethiopia. A purposive simple random sampling technique was used to identify 7 dairy farmers that have different size and business models. Research methods such as desk study, case study, observations and focus group discussions were applied. Research tools such as structured and none structured interviews guided by a checklist were used to extract data from respondents. These were complemented by observations and focus group discussion. In order to get in-depth information, a total of 2-4 days was spent observing and collecting data at each farm. The LCA model was used as a guide in data collection checklist and GHG quantification by taking into account all emission from cradle to the farm gate based on IPCC (2006 version 2014) guidelines.

Dairy farming in Shashamane-Ziway milk shed

Shashamane–Ziway milk shed is located in the mid-rift valley area and it has very good climatic conditions that give the area high potential for dairy farming. However, dairy farming is dominated by subsistence farmers with indigenous breeds and not very business-oriented. The main challenges in the milk shed is feed quality and availability and this contributes to the low productivity in the milk shed. As observed by Tesfahun (2018) and Endale (2018) farmers have implemented climate smart practices such as use of artificial insemination especially in the urban areas and less in rural areas, because of the inefficiency in the artificial insemination service. Use of exotic crossbreeds with high milk yield potential was observed by Tesfahun (2018) and Endale (2018) especially in urban areas. The main feed resources observed by Tesfahun (2018), Endale (2018) and Van Geel et al. (2018) are crop residues and concentrates. Homemade rations are very common as farmers try to cut on the feed cost considering professionally formulated rations are very expensive. Farmers source the concentrates feed from feed agents and roughages for urban farmers can be sourced from the marketplace with no long term relations. Farmers in the study were not members of a cooperative though they mentioned that there were cooperative in the area especially in Shashamane.

Climate Smart Dairy practices

The case studies identified 14 major climate smart dairy practices implemented at farm level, mainly to increase productivity (Table 1).

Table 1. *Climate smart dairy practices identified and the level of adoption per farm*

Theme	Indicators	WA1	WA2	WA3	ES1	ES2	ES3	ES4
Feeds	Fodder production		Green			Green		
	Use of concentrates	Green	Green	Green	Green	Green	Green	Green
	Straw treatment					Red	Red	
	Use on mineral supplements	Red	Red	Red	Red	Yellow	Red	Red
	Accuracy in feed allocation	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
Electricity consumption	Minimum use of machinery	Green	Green	Green	Yellow	Yellow	Yellow	Green
	Use of milking machine					Green		
Water	Water availability	Red	Red	Red	Green	Green	Green	Green
	Water quality	Yellow	Red	Yellow	Yellow	Yellow	Yellow	Yellow
	Water harvesting from wells				Yellow	Yellow	Yellow	Yellow
Animal welfare	Improved housing	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
	Herd health management	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
	Cow maintenance (hoof trimming and dehorning)	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
	Use of antibiotics	Red	Red	Red	Red	Red	Red	Red
	Zero-grazing units	Green	Green	Green	Green	Green	Green	Green
	Cowshed with concrete floors for easy cleaning	Green	Green	Green	Green	Green	Green	Green
Manure management	Biogas		Yellow	Yellow	Yellow		Yellow	
	Separation of urine and cow dung	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
	Use of manure as a fertiliser	Yellow	Yellow			Yellow		
Maximising productivity	Use of improved breeds	Green	Green	Green	Green	Green	Green	Green
	Use of artificial insemination	Green	Green	Green	Yellow	Yellow	Green	Green
	Replacing male animals with females	Green	Green	Green	Yellow	Yellow	Yellow	Yellow
	Cow productivity (age at first calving and calving interval)	Red	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
	Ration formulation and feed conversion efficiency	Red	Red	Red	Red	Red	Red	Red

Note: The level of adoption is colour coded with red<30%, yellow ≥30-60%, and green≥60%. No colour represents a climate smart practice that was not implemented.

The productivity per lactation (3273 L) and per cow per year (2436 L) (Table 2) are higher compared to similar studies (Ndambi et al., 2017; De Vries et al, 2016). This shows that the farmers are adopting dairy farming as a business therefore having surplus milk for sell in a priority over home consumption. Despite the adoption of climate smart practices that contribute towards intensification of productivity per cow, other factors such as herd management, feed supply and quality are limiting productivity hence the wide margin between productivity per lactation and productivity per year.

Table 2. *Production performance per farm*

Farm	Milk production / lactation (litres)	Lactation days	Age at first calving (months)	Calving interval (months)	Lactation length per year (days)	Litres milk per year	Average production per day (litres)	Peak lactation (litres)	Replace ment (years)
WA1	2160	270	24	450	219	1752	4.80	8.16	4
WA2	3510	270	36	540	183	2373	6.50	11.05	7
WA3	3073	270	24	480	205	2337	6.40	10.88	7
ES1	2376	270	30	540	183	1606	4.40	7.48	7
ES2	5225	270	26	450	219	4238	11.61	19.74	6
ES3	3675	250	30	480	190	2795	7.66	13.02	7
ES4	2891	300	24	540	203	1954	5.35	9.10	8
Ave	3273	271	28	497	200	2436	7	11	7

Use of zero grazing units
In all the seven case studies zero grazing system was observed. This reduced the amount of energy the animals spend grazing hence channelling the energy towards production. The zero grazing unit had concrete floors with a gentle slope for easy cleaning.

Use of exotic crossbreeds
All farmers had the Holstein-Frisian breed which has high milk yield potential. Despite the increase in the milk yield, it was still below the potential of the breed, showing that other factors were limiting the productivity of the cows. Use of indigenous breeds was observed at the peri-urban farm as a measure to produce butter for home consumption (Fig. 1).

Figure 1. *Exotic cross breeds*

Use of AI
All farmers depended on AI including the peri-urban farmers. However, the inefficiencies in the AI service delivery resulted in some of the farmers keeping bulls as back up.

Use of concentrates
All farmers supplemented the roughage feed with concentrates though the choice of concentrates varied with location and the ability of the farmer to afford the concentrates. This resulted in increased milk yield in most of the farms despite the variation in milk yield between the farms.

Figure 2. *Napier production in Ziway*

Fodder production
Feed supply and quality remains a weak link in the study area as farmers depend on crop residues. Despite this fact, fodder production was only observed in two out of the seven farms. However, these farmers only produced Napier grass and maize hence the missed opportunity of growing leguminous fodder plants which can improve the feed quality and supply at the same time creating carbon sink. Agroforestry was also observed as a conservation agriculture practice that minimises the release of carbon stored in the soil and creation of carbon sinks (Figure 2 and 3).

Figure 3. *Maize production in Shashamane*

Keeping a female herd
Farmers in West Arsi kept female animals only. This is important in reducing GHG emissions as a result of keeping less non-milking animals. However, farmers in East Showa kept a bull and this increased the GHG emissions per litre of milk.

Separation of urine and dung
In all seven case studies the cow barns had concrete flow with a gentle slope that enable the separation of dung and urine. This reduced the amount of urine ammonia formation and volatilisation losses.

Straw treatment
Considering that the dairy farmers in Ethiopia depend on crop residues that have digestibility ranging around 55%, straw treatment with urea presents an opportunity to improve the digestibility of the feed at the same time improving productivity per animal. Only two farmers that they treat straw although it wasn't done on a daily basis. Therefore, its benefits remain insignificant hence, it remains a missed opportunity (Figure 4).

Figure 4. *Straw treatment*

Manure management using the anaerobic biogas digester
Three farmers had a functioning biogas digester whilst the fourth farmer had a newly constructed biogas digester although not functioning at the time of the study (Figure 5). The biogas digester was observed as the most climate smart practice in the study with the most reduction in GHG emissions followed by composting. However, the cost of investing in the biogas digester were quite high and this may limit the adoption of the practice especially for farmers that already have low electricity consumption. Absence of composting as manure management system remains a missed opportunity that can reduce GHG emissions significantly.

Access to information
Farmers in East Showa were members of the farmer research group supported by Adami Tulu Agricultural Research Centre. Any farmer (men, women and youth) had access to joining the farmer research group as shown by representation of both sexes and age groups especially in East Showa. The peri-urban farmer in West Arsi had access to government extension service and NGOs such as SNV whilst

the urban farmers depended on development agents. This enabled farmer access to information and peer to peer training considering extension service was not available to farmers in urban areas. However, more still need to be done to improve the quality of information that the farmers have access to as shown by the variation in milk yield per cow yet the farmers have the Holstein-Frisian breed.

Figure 5. *Anaerobic biodigester*

Water harvesting
Three of the farmers in East Showa used ground water from wells drilled within the farms and the water was stored in tanks to ensure animals had ad lib access to water. However, in West Arsi no water harvesting structures were observed with the peri-urban farmer depending on murky water from the stream which was no longer flowing all year round. However, in both areas water quality and its portability was questionable.

Minimum use of machinery
The farmers in West Arsi did not use any machinery on farm whilst in East Showa three of the farmers had choppers whilst one farmer had two small milking machines. The rest of farmers that did not use electrical of fuel powered machinery resorted to manual labour to chop the fodder and milk the cows. This reduced the total energy consumption within the farms. Use of heavy machinery was observed during feed production and harvesting through use of tractors and combined harvesters although total number of farmers using machinery is still low.

Herd health management
Farmers invested in herd health management to ensure the cows are in optimum health in order to produce at full potential. However, disease such as mastitis and calf mortality of 2% was reported. Productivity per cow per year was low compared to the lactation production mainly as a result of long age at first calving and long calving interval. (see Table 1). There is also need to enforce control measure where access and administration of antibiotics is concerned in order to prevent antibiotic resistance in cows and also contamination of the milk that is sent to the market.

Use of manure as a fertilizer
Farmers that have fodder production or land for other crop production used manure as fertilizer. This improves the waste management within the farm whilst at the same time reduces the total amount of artificial fertilizer required per hectare. However, the full benefit of the use of manure as fertilizer may not be realized considering that before the application of the manure on the land it was stored in a solid storage and this results in losses of nitrogen through volatilization and leaching of nutrient

Based on different climate smart practices the carbon footprint of fat and protein corrected milk (FPCM) varied from one farm to the other. Although milk yield has improved the variation in milk yield between farms still shows that farmers can learn from the best performing farms in order to reduce the carbon footprint per litre of milk.

Conclusions

The climate smart practices observed include Artificial Insemination (AI), separation of cow dung and urine, use of biogas digester, use of zero grazing units, fodder production, use of concentrates to improve feed quality use of Holstein-Frisian exotic crossbreed, keeping of female herd, minimum use of machinery, water harvesting, herd health management, use of manure as a fertiliser, access information and straw treatment. Farmers in West Arsi all had female herds only whilst East Showa farmers had herds that included bulls which were kept as back-up for AI and also pen fattening. Water harvesting was observed in East Showa. In comparison to findings by Endale (2018) and Tesfahun (2018) show a marked increase in the number of climate smart practices observed. No clear trend was observed on productivity per farms considering both regions had farms that had both low and high productivity. Tesfahun (2018) and Endale (2018) observed use of indigenous breed in the peri-urban areas, use of dung as fuel, use of bulls and indigenous breeds. The findings in this study showed that the peri-urban farmer had very high productivity, used exotic cross breed and AI and this contradicts finding by Tesfahun (2018) and Endale (2018). This presents an opportunity for the adoption of dairy farming as a rural entrepreneurship and also where manure has more functions than in urban areas.

References

- Baars, R., Verschuur, M., Eweg, R. and De Vries, J. (eds.), 2019. Inclusive and climate smart business models in Ethiopian and Kenyan dairy value chains. Practice briefs CSDEK project. Van Hall Larenstein, Velp, The Netherlands.
- De Vries, M, Yigrem, S., Vellinga, T. 2016. Greening of Ethiopian Dairy Value Chains. Wageningen UR Livestock Research, Report 948
- Endale, S. 2018. Opportunities for scaling up climate smart Dairy Production in Ziway–Hawassa Milk Shed, Ethiopia. Master thesis, VHL-Velp, The Netherlands.
- IPCC, 2006. IPCC Guidelines for National Greenhouse Gas Inventories prepared by the National Greenhouse Gas Inventories Programme, Eggleston, H.S., Buenida, L., Miwa, K., Nagara, T. & Tanabe, K. (eds). Published: IGES, Japan.
- Mudombi, B., 2019. Cost-benefit analysis and GHG emission in dairy business models: A case study of Shashamane-Ziway milk shed, Ethiopia. Master thesis, VHL-Velp, The Netherlands.
- Ndambi A., J. van der Lee, T. Endalemaw, S. Yigrem, T. Tefera and K. Andeweg, 2017. Four important facts on opportunities in the dairy sector. Practice briefs DairyBISS project. Wageningen Livestock Research, Wageningen.
- Tesfahun, T.B., 2018. Carbon Footprint of Milk at Smallholder Dairy Production in Zeway – Hawassa Milk Shed, Ethiopia. Master thesis, VHL-Velp, The Netherlands.
- Van Geel, S., Vellinga, T., Doremalen, L. van, Wierda, C., Claassen, F., Dros, J.M., 2018. From subsistence to professional dairy businesses: Feasibility study for climate-smart livelihoods through improved livestock systems in Oromia, Ethiopia. Solidaridad, Utrecht. Available at https://www.solidaridadnetwork.org/sites.

A study on the relation between carbon footprint and dairy farm profitability: A case study in Shashamane-Ziway milk shed in Ethiopia

Blessing Mudombi, Marco Verschuur, Robert Baars

Practice Brief
CSDEK Project 2020-02

CSDEK = Inclusive and climate smart business models in Ethiopian and Kenyan dairy value chains

van hall larenstein
university of applied sciences

Van Hall Larenstein University of Applied Sciences (VHL) carried out research in the frame of the NWO-GCP-CCAFS funded 'Climate Smart Dairy in Ethiopia and Kenya' (CSDEK) project on inclusive, resilient climate smart strategies that can be scaled up in the dairy sector in Ethiopia. The research conducted by CSDEK in 2018 (Baars et al., 2019) gave an understanding of the dairy value chain, the dairy farming systems and the climate smart practices implemented together with the respective GHG emissions for various activities in the value chain. The study gave insights in the different dairy farming systems and gender roles within these farming systems. However, the link between GHG emissions and the profitability of the dairy business, economic and environmental costs that come from each climate smart practice implemented were not established.

The aim of this study is to evaluate the link between dairy farm profitability and GHG emissions, based on the impact of each climate smart dairy practice implemented in order to develop interventions for scaling up of practices that support low-emission dairy development.

Methodology

The study was carried out on dairy farms in East Showa and West Arsi region of Oromia in Ethiopia. A purposive simple random sampling technique was used to identify seven case studies, three in West Arsi and four in East Showa. Research methods such as desk study, case study, focus group discussion and observation were applied. Research tools including both structured and non-structured questionnaire and checklists were used to extract data from respondents. The life cycle assessment (LCA) based on IPCC 2006 guidelines and partial budgeting and cost benefit analysis were used in calculating the GHG emissions and the economic cost and benefits respectively for each climate smart practice implemented.

Research boundaries and functional unit

The research focused on the upstream and on-farm assessment of all input-output activities from cradle to farm gate. The analysis focused on dairy farming systems and the subsystems within the farm based on the input-output connections and, how they influence GHG emissions and profitability per climate smart practice implemented. Both on-farm (enteric fermentation, manure management system) and off-farm emissions (fossil fuel energy generation, emissions during crop production, transport, land use, and land-use changes) were considered in comparison with the gross margins, partial budget and cost-benefit analysis. Based on Weiler et al. (2014), the multi-functionality of dairy animals was considered from an economic, food and livelihood perspective in the allocation of GHG emissions. Other environmental impacts of dairy farming in the urban and peri-urban farming system were considered. Although home processing of milk was considered an on-farm activity, none was observed in this study.

Production performance parameters

Farm production performance was measured by milk yield per cow, calving interval, lactation days, age at first calving, lactation length and this was based on the information given by the farmer and it was verified by going through farm records where possible. The number of cows that calve per year and the number of calves on the farm were used to verify the calving interval.

GHG emissions and Life Cycle Assessment (LCA)

The quantification of GHG emissions was carried out using the life cycle assessment based tier 2 and 3 of IPCC (2006, version 2014) formulas and guidelines from cradle to farm gate.
LCA is a tool that can be used to assess the environmental impacts of a product throughout its production chain and disposal (Weiler et al., 2014). The LCA method involves the systematic analysis of production systems, to account for all inputs and outputs associated with a specific product within a defined system boundary (FAO, 2010). This enables the identification and exclusion of measures that simply shift environmental problems from one phase of the life cycle to another. The system boundary depends on the goal of the study. In this study the goal was to establish economic and environmental costs from cradle to farm gate therefore cradle to farm gate becomes the research boundary. The reference unit denotes the useful output of the production system and it is based on a defined quality and quantity. In this study the reference unit is based on a kilogram of fat and protein corrected (FPCM) milk and the indicators are greenhouse gases (CO_2, CH_4, and N_2O). There are challenges in using the LCA tool in agriculture system as a result of agriculture products having multiple outputs accompanied by joint production of by-products. Therefore, there is a need for the partitioning of environmental impacts to each product from the system according to the allocation rule based on economic value product properties (FAO, 2010).

Cost price and profitability

Feed costs constituted the highest of the production costs. Other costs included direct costs (veterinary and artificial insemination) and indirect costs (labour, transport, water, electricity). The price of milk varied with the area and market channel (Table 1). Urban farmers (WA1, WA3, ES1, ES3 and ES4)- had extra cost of disposing manure, mainly transport cost. The profit per litre of milk is very low when milk only is considered as revenue and it goes up when other dairy products such as manure and live animal sales (bull calves, fattened bulled and old cows) are considered. An increase in dairy farm profitability when other dairy products and by-products are included shows the importance of capturing the economic value of all products as a measure to increase resilience within the farm.

Cost price was lowest in farms that had high milk productivity per cow showing that intensifying productivity per cow can reduce production cost per litre.

Based on different climate smart practices, the carbon footprint of fat and protein corrected milk (FPMC) varied from one farm to the other. Although milk yield has improved, the variation in milk yield between farms still shows that farmers can learn from the best performing farms in order to reduce the carbon footprint per litre of milk (Table 2).

The life cycle assessment method was used to quantify the total GHG emissions from cradle to farm gate which make up the carbon foot print of milk.

__Table__ 1. Cost price and profitability [ETB/per litre milk]

Farmer	Production cost	Milk price	Revenue of milk and other products	Profit for all products	Profit from milk only	Cost price
WA1	32.31	24	25.25	-7.06	-8.31	1.20
WA2	20.27	21	21.31	1.04	0.73	0.94
WA3	19.10	21	22.76	3.67	1.90	0.74
ES1	42.16	22	28.17	-13.99	-20.16	0.97
ES2	19.00	22	26.75	7.75	3.00	0.55
ES3	18.48	22	22.81	4.33	3.52	0.78
ES4	38.32	26	27.60	-10.72	-12.32	1.27

***Table 2.** Summary of the carbon footprint per litre of milk.*

	Herd size	Milk production (litre per year)	Enteric emission per litre FPCM	Emission concentrate	Feed production Emission	Emission from crop residue	All feed transport emission	Emission CH_4 & N_2O	Carbon foot print
WA1	4	3500	2.32	1.54	0.24	0.16	0.04	0.27	4.42
WA2	29	49773	1.23	0.14	0.06	0.03	0.16	0.13	1.70
WA3	12	18675	1.45	0.47	0.08	0.05	0.05	0.14	2.15
ES1	19	12835	3.49	0.68	0.13	0.09	0.16	0.39	5.07
ES2	64	110079	1.24	0.12	0.04	0.03	0.02	0.13	1.47
ES3	34	47460	1.31	0.29	0.05	0.03	0.03	0.21	1.76
ES4	16	15617	2.37	0.49	0.09	0.06	0.05	0.23	3.29

***Table 3.** Carbon footprint per kg milk (kg CO2 eq/kg FPCM) for different IPCC conversion factors for 3 systems: peri-urban (PU), urban with land (UL) and urban without land (U).*

	WA1	WA2	WA3	ES1	ES2	ES3	ES4	Average
	UL	PU	U	U	UL	U	U	
CH_4-21 and N_2O-310	4.42	1.7	2.15	5.07	1.47	1.76	3.29	2.84
CH_4-28 and N_2O-265	4.34	2.08	2.29	3.16	1.93	2.36	2.46	2.66
CH_4-34 and N_2O-298	4.91	2.44	2.67	3.78	2.32	2.77	2.94	3.12
Profit/litre all products considered [Etb]	-7.06	1.04	3.67	-13.99	7.75	4.33	-10.72	-2.14

The carbon footprint of milk

Enteric emission ranged between 1.23 and 3.49 kg CO_2-eq per litre of FPCM whilst the overall carbon footprint ranged between 1.47 and 5.07 kg CO_2-eq per litre of FPCM (table 2). Enteric emissions shown in table 2 are much lower than observed by Tesfahun (2018) who found a carbon footprint of 2.07 and 4.71 kg CO_2 eq unallocated emissions in urban and peri-urban farms. A total of four farms have carbon footprint less than 2.36 therefore I propose to compare GHG emissions with production levels observed by Van Geel et al. (2018) who found enteric emissions of 2.36 kg CO_2 eq /kg FPCM in commercial farms**.** The peri-urban farmer (WA2) in this study has exotic breed just like urban farmers and has a carbon footprint of 1.68 kg CO_2 eq/litre much lower than the other urban farmers. In both studies enteric emissions contributed the most in on-farm and off-farm emissions. This makes feed the key area in GHG emission reduction in the study area.

The relationship between the carbon footprint and profitability (Table 3) shows a trend of farms with low carbon footprint also having high profit whilst farms with high emissions show and a loss. In Table 3 different IPCC conversion factors for CH_4 and N_2O are considered.

Table 4 shows the climate smart practices that were observed during field work. Use of exotic Holstein-Friesian breed was observed on all the farms and it had contributed to high milk yield per cow annually. Although use of anaerobic biogas digester resulted in a reduction in GHG emissions, the cost of investing in installation maybe deterring farmers from adopting the practice as shown by just four farms having biogas digesters.

Conclusions

For urban farmers (without land) there is no market for manure; these farmers incur the cost of disposing the manure mainly in form of transport cost. It was observed in this study that feed quantity and quality is one factor limiting the dairy sector in East Showa and West Arsi, therefore supplementation with concentrate, crop residue treatment and fodder production can be used to boost productivity. Table 4 shows scalable climate smart practices, however, depending on the farmer's business model the climate smart practices do not always give positive results. Therefore, an in-depth of the farm analysis should be carried out in order to establish the most climate smart practices for that specific farm. The scalable climate smart practices observed are use of high yielding exotic breeds, composting, biogas, straw treatment, use of concentrates, AI and female only herd.

References

- Baars, R., Verschuur, M., Eweg, R. and De Vries, J. (eds.), 2019. Inclusive and climate smart business models in Ethiopian and Kenyan dairy value chains. Practice briefs CSDEK project. Van Hall Larenstein, Velp, The Netherlands.
- FAO, 2010. Greenhouse Gas Emissions from the Dairy Sector. A Life Cycle Assessment. FAO, Rome, Italy
- IPCC, 2006. IPCC Guidelines for National Greenhouse Gas Inventories prepared by the National Greenhouse Gas Inventories Programme, Eggleston, H.S., Buenida, L., Miwa, K., Nagara, T. & Tanabe, K. (eds). Published: IGES, Japan.
- Mudombi, B., 2019. Cost-benefit analysis and GHG emission in dairy business models: A case study of Shashamane - Ziway milkshed, Ethiopia. Master thesis, VHL-Velp, The Netherlands
- Tesfahun, T.B., 2018. Carbon Footprint of Milk at Smallholder Dairy Production in Zeway – Hawassa Milk Shed, Ethiopia. Master thesis, VHL-Velp, The Netherlands.
- Van Geel, S., Vellinga, T., Doremalen, L. van, Wierda, C., Claassen, F., Dros, J.M., 2018. From subsistence to professional dairy businesses: Feasibility study for climate-smart livelihoods through improved livestock systems in Oromia, Ethiopia. Solidaridad, Utrecht. Available at https://www.solidaridadnetwork.org/sites. [Accessed 10 February 2019].
- Weiler, V., Udo, H.M.J., Viets, T.C., Crane, T.A., de Boer, I.J.M., 2014. Handling multi-functionality of livestock in a life cycle assessment: the case of smallholder dairying in Kenya. In: Environmental Sustainability, 8, 29–38.

Table 4. *GHG emissions per climate smart practice implemented and gross margins*

Climate smart practice	**Gross margin**	**WA1**	**WA2**	**WA3**	**ES1**	**ES2**	**ES3**	**ES4**
High yielding exotic breeds	Additional Gross margin [ETB]	37,920	586,800	223,680	283,680	1,029,480	544,400	321,840
	Enteric emission (Holstein-Frisian)	-69%	-79%	-71%	-66%	-85%	-84%	-69%
Composting	Additional Gross margin [ETB]	2,472	22,871	12,526	20,127	65,077	62,755	15,572
	% Reduction in emissions	-15%	7%	5%	-15%	-15%	7%	-15%
Biogas	Additional Gross margin [ETB]	- 28,800	-81,600	- 13,200	-25,200	825,840	- 50,400	178,800
	% Reduction in emissions	-40%	-25%	-25%	-40%	-40%	-25%	-40%
Straw treatment	Additional Gross margin [ETB]	7,489	164,199	60,094	32,941	153,009	64,859	68,793
	Reduction in enteric emissions	31%	12%	29%	49%	6%	3%	42%
Female only herd	Additional Gross margin [ETB]				20,816	-147,600	207,550	188,498
	% Reduction in GHG	0%	0%	0%	38%	30%	26%	37%
AI	Additional Gross margin [ETB]	- 19,275	- 62,847	- 87,642	- 56,588	0	0	0

Inclusiveness and resilience for scaling up climate smart dairy farming. A case of Ziway-Hawassa milk shed, Ethiopia

Mina Mehdi Hassn, Robert Baars and Leonoor Akkermans

Practice Brief
CSDEK Project 2020-03

CSDEK = Inclusive and climate smart business models in Ethiopian and Kenyan dairy value chains

The dairy sector in Ethiopia is dominated by male and female smallholders and a small number of (semi-) commercial farmers. It is characterized by low productivity, limited availability of chilling in rural areas, processing plants working below capacity, prices volatility, fluctuating demands (fasting) and informal dairy markets resulting in high emissions per kilogram of milk and low climate resilience. Value chain development needs to be supported and should be inclusive for women, youth and other marginal groups, so as to ensure that economic and resilience benefits are widely shared.

Despite the many studies and ongoing developments, the sector faces challenges in scaling up good climate smart practices. The growth of the dairy sector and the emergence of formal dairy chains offer opportunities for climate smart dairy practices that increase efficiency and reduce losses.

The aim of this study was to analyse the male and female dairy farmers' awareness, knowledge, and skills on climate smart dairy as regards to inclusiveness and resilience.

Individual interviews were conducted among 12 dairy farmers (6 men and 6 women, both youth and adult) and 11 key respondents from farmers knowledge and information networks. Five focus group discussions were held with groups of only men, only women or mixed. Ziway, Adami Tulu, Shashemene and Arsi Negele districts were selected.

The conceptual framework of the study was a combination of the Sustainable Livelihood Framework (DFID, 1999), Resilience Framework (Bene et al, 2012) and Social Inclusion Framework (Figure 1). The information gathered in the study was the vulnerability context, assets, adoptive capacity, agricultural knowledge and information networks of dairy farmers (men, women and youth).

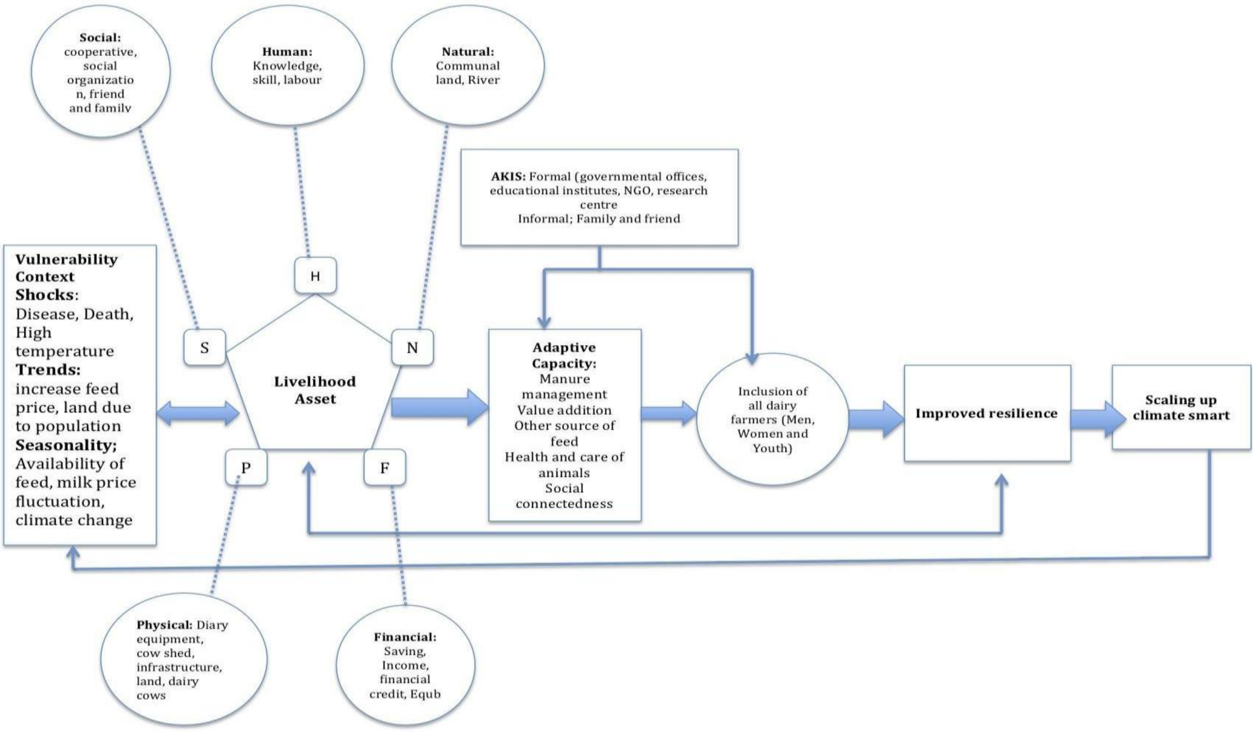


Figure 1. *Conceptual framework of the study.*

Vulnerability

The vulnerability context that affected the dairy farms in the study were feed unavailability and high feed prices, milk and milk product price fluctuations, especially during holydays and fasting times, climate change, unavailability of land for pasture or planting forage, and disease and death of dairy cattle.

Livelihood assets

Dairy farmers coped with this vulnerability through different strategies and activities such as value addition through milk processing, use of by-products and crop residues during difficult times. Asset endowment for dairy farmers was a main constraint they faced in scaling-up their dairy farms and to be more resilient. Physical, financial, human, natural, and social capital of women, men and youth in the milk shed was limited. Financial, human and physical assets of men were higher compared to women, but women had higher social capital (Figure 2). The social connectedness of the dairy farmers among themselves, friends and neighbours was very strong. This helps them to cope during difficult times and get knowledge and information. Most of them were in touch with the “Kebele’s” (smallest administrative unit) developmental agents although not on a regular basis. All twelve respondents were part of the social organization called “Edir” and most of the females (5) had “Equb” rotational local money activity. None of the respondents had a loan from any formal financial institution; in the focus group discussions this was attributed to lack of collateral and religious belief against lending and borrowing on interest.

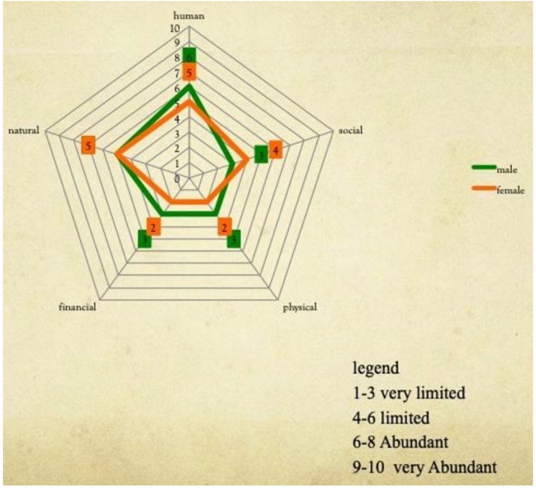


Figure 2. *Asset pentagon of male and female dairy farmers.*

Gender in dairy farming

Women in the milk shed participated in almost all dairy practices from feeding to selling milk and milk products (Table 2). However, large farms used young men for taking care of their cows. Men purchased and transported feed and choose the type of breed. Women do not have power to sell milking cows without the consent of the men (Table 1).
The knowledge and information networks all give priorities to women and youth who want to be involved in dairy farming. The policy of the Government of Ethiopia is working on empowering women and youth by integrating gender issue into most governmental organizations. However, ensuring women and youth to attend training and information is difficult since women are busy in their homes and youth were not much enthusiastic about farming and dairy. Most female participants in the focus group discussions were also doing their reproductive role as a woman. Five of the key informants indicated that women accept and adopt new technologies easier than men, especially in dairy since they are more involved in dairy activities. Moreover, youth are using modern technologies and the Internet to get information. This information was also validated from the observations made where a young model farmer was using Internet for getting information.

The interviews learned that accessing productive resources is difficult for both male and female dairy farmers. However, if there are resources, men will have the first hand to access and control it.

Table 1. *Access and control of resources of men and women*

Assets/Resources	Women	Men
Land	A	A/C
Dairy cows	A	A/C
Income from dairy	A/C	A
Dairy farm labour		A/C
Equipment	A	A/C
Training, extension	A/C	A/C
Education	A/C	A/C
Social networks	A/C	A/C
Exposure new ideas	A/C	A/C

Adaptive capacity and resilience

Knowledge, information and assets enable dairy farmers to cope with difficult times. The adaptive capacity of dairy farmers mentioned in interviews and focus group discussion were use of communal land, milk processing, manure management, livestock health and hygiene. All respondents indicated that the main problem to increase their milk production was the lack of feeds due to shortage of land. Seven respondents used communal land for grazing, whereas five respondents used cut and carry techniques, or used crop residues from their farms or purchased it. The manure from the dairy cattle was mostly used for maize, teff, and vegetable production. Seven respondents highlighted that they use dried cow dung as a source of fuel, and one used biogas.

"All the people in the community here have dairy cows. Dairy products may be

used for household consumption or sale. No one will purchase milk since they all produce. Therefore, the only chance we have to generate income is to process the milk into butter and traditional cheese and sell it on market days. Processing is one way of keeping the milk to last long."

Female Respondent

Climate smart practices are important in improving resilience of farmers and increase their productivity. However, most of the smallholder farmers do not practice climate smart dairy activities such as manure and dung separation, good cattle housing, financial and insemination record keeping, planting of forage, and water harvesting technologies. None of the farmers had heard about climate smart dairy even if most of the dairy farmers use manure for composting.

Table 2. *Dairy activities based on gender*

Activities	Male-headed households				Female-headed households		
	Male	Female	Youth Male	Youth 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	_	√	_	_	√	_	_

Picture 1. Butter and cheese in a local market

Agricultural knowledge and information systems (AKIS)

Formal and informal knowledge and information networks provide service and support for the dairy farmers. Informal knowledge and information networks, especially friends and family, is the main source of information for dairy farmers. Figure 3 below is a Venn diagram showing the institutions and organization involved in the knowledge and information system. The bigger the size of the circle, the higher the influence. None of the male respondents mentioned Adami Tulu Agricultural Research Centre, there is no interaction with the farmers even though it has great influence in dairy research. NGO's like SNV had more interaction with female dairy farmers as compared to the male farmers. Only one male respondent mention Alage ATVET.

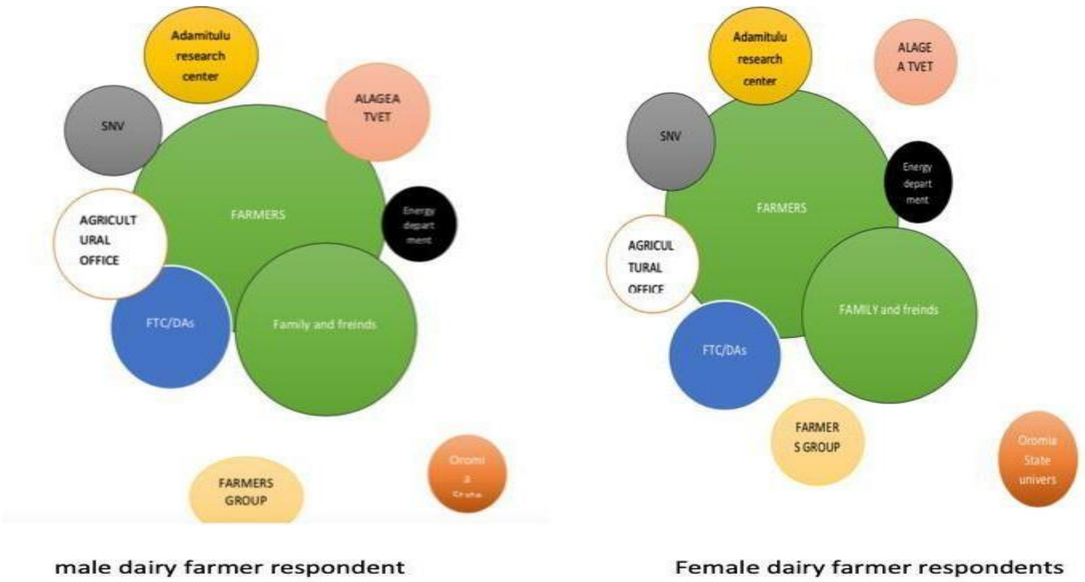


Figure 3. Venn diagram perceptions of dairy farmers in relation to knowledge and information networks

Conclusions

- There is lack of awareness about climate smart dairy, also if farmers practice it. Land availability and space for forage production is the greatest challenge limiting scaling of good practices. Some farmers use cow manure as a fertilizer, others as a source of fuel.
- Value addition of milk to butter and cheese is highly practiced by female dairy farmers in the absence of formal markets.
- Assets are very limited. Men have more financial, human and physical assets, women have more social capital. Female dairy farmers build social connectedness through participating in social organization that helps them to be resilient ("Edir"and "Equb").
- Female dairy farmers are favoured in support from knowledge and information networks as compared to men, especially from NGO's, research institutes and agricultural college.
- Knowledge and information networks of dairy farmers are formal and informal. The informal for dairy farmers are family and friends. The formal include Adami Tulu Agricultural Research Center, Alage ATVET, ILRI forage seed multiplication, SNV (NGO), Energy development and Agricultural offices, especially livestock and fishery. The effectiveness of formal networks is doubtful since dairy farmers in the milk shed do not get much information and knowledge from formal institutions, as compared to what these institutions perceive to have given. Further, they are mainly working with

model farmers or farmers with productive assets who are more likely to adopt technologies. This affects the inclusion and technology adaptability of most dairy farmers who have limited assets.

Recommendations

- In scaling-up technologies, farmers easily tend to adopt and practice technologies which they consider to have an impact on their livelihood. Therefore, participatory information approaches like FRGs should be used to help the farmers understand their impact. The commissioner in collaboration with Adami Tulu Agricultural Research Centre should develop programs with more dairy farmers participation in FRGs, particularly focused on forage production.
- Agricultural offices should provide quarterly based hand-on training to DA's that will help them to upgrade their practical knowledge and skills about climate smart dairy practices.
- Reaching every household of dairy farmers by only three developmental agents is difficult. Therefore, farmers should efficiently work in transferring their knowledge and information gained through different institutions by actively participation and involvement in one to five development groups.
- Existing cooperative should link with nearby brewery factories like BGI Hawassa and Anbessa brewery factories (Mojo) so that dairy farmers can access alternative protein rich feed.

References

- Bene C., Wood R. G., Newsham A. and Davies M. 2012. Resilience: New utopia or new tyranny? Reflection about the potentials and limits of the concept of resilience in relation to vulnerability reduction programmes. IDS (Institute of Development Studies) Working Papers 2012: 1-61.
- DFID. 1999. Sustainable livelihoods guidance sheets. Department for International Development, London, UK. guides/livelihoods. [Accessed 28 February 2019].

The role of knowledge networks in scaling up climate smart agriculture practices around the Kiambu dairy value chain, Kenya.

Catherine Namboko Wangila, Rik Eweg and Marco Verschuur.

Practice Brief
CSDEK Project 2019-06

CSDEK = Inclusive and climate smart business models in Ethiopian and Kenyan dairy value chains

Kenya, as a signatory to the United Nations Convention on Climate Change (UNFCCC), aims to implement a Climate Smart Agriculture (CSA) strategy with three main objectives: sustainably increasing agricultural productivity and incomes; adapting and building resilience to climate change; and reducing and/or removing greenhouse gas emissions, where possible (Government of the Republic of Kenya, 2017). In the Implementation Framework following Kenya's CSA Strategy, the role of knowledge, dissemination, establishment of knowledge networks, partnerships and hubs are considered important components (Ministry of Agriculture, Livestock, Fisheries and Irrigation, 2018).

CSA knowledge is still isolated. Knowledge networks and dissemination are important tools for scaling up CSA practices developed by researchers and farmers. Public, private and knowledge actors face the challenge to implement their innovative methods and technologies in the Dairy value chains and business models of farmers and other value chain actors. The objective of the study reported in this brief, was to describe and analyse knowledge networks on CSA around Kiambu County. Based on this, recommendations are given how to further develop and extend CSA knowledge networks to integrate CSA in Kenyan dairy value chains and farmers' business models.

Dairy in Kiambu County

Kiambu County is located in Central Kenya and has an area of 1448 km^2. The county consists of 12 sub-counties with a population of 253,751. Temperatures range from 12.5^{0}C in July/August in the upland zone to 20.4^{0}C in March/April. Important (semi-)urban markets for the county are Kiambu, Ruiru and Nairobi with accessible processing factories. In 2017, in Kiambu, 260,091 cows produced 293,377,973 litres of milk, leading to an average of 1128 kg/cow/year. The county is the highest milk producer of Kenyan counties.

CSA in educational curricula and programs

Climate change is part of most curricula in Universities. Universities, Colleges and Technical and Vocational Education and Training institutes (TVETs) were visited and interviewed (see table 1). All of them paid attention to climate change or CSA practices in their curricula and training programs. Most universities and all colleges and TVETs collaborate with farmers.
Kiambu County's Ministry of Environment and Natural Resources even aims to implement CSA

practices in the curricula of 60 public schools in its county. As barriers for scaling up CSA practices the institutes mentioned underfunding, inadequate and obsolete equipment and facilities, poor procurement logistics and lack of a guiding policy (curriculum), understaffing.

University farms for practical research and training

University farms are important for practical research and training. Five universities have own farms: Ahiti Ndomba College, Egerton University, University of Nairobi (Animal production), Baraka Agricultural College and Naivasha-DTI. The universities implement several CSA practices on their farms: tree planting, grazing animals in paddocks, biogas utilized in kitchens (Egerton and Baraka), manure and slurry used on the farm for fodder production.

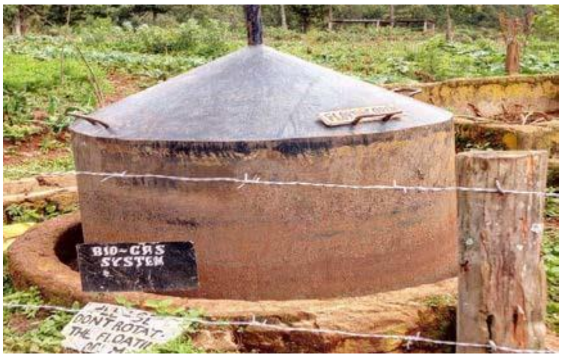


Figure 1. *Bio-digester at Baraka.*

Knowledge Institutes collaborate with farmers

Colleges and universities collaborate with farmers in implementing CSA practices. Egerton University works with smallholder farmers in five counties: Kilifi, Bungoma, Nakuru, Kajiado and Tharaka Nithi. The university provides knowledge transfer particularly on greenhouse and animal husbandry practices. In Kilifi, Egerton is training farmers on animal feeds and dairy goat management and in Bungoma, the institution is helping farmers to establish fishponds and greenhouse projects for vegetable farming. In Nakuru, smallholder farmers receive support on irrigation and dry land crop production. In Kajiado, the university offers practical training on kitchen gardening to women groups, water harvesting and goat farming. Egerton University supports smallholder fruit farming, legume crop farming and rearing of alpine goats in Tharaka Nithi County.
Baraka Agricultural College works in five villages within its vicinity, providing support to smallholders. With support from donors, the agricultural college offers the following services: transport facilitation, poultry bags, kitchen seeds and canny bags for vegetable farming to farmers in Shalom, Kisii Dogo, Bahati, Twin Stream and Someto. Baraka also involves its students in outreach programs in the field. Certificate and diploma students train smallholder farmers on compost production, dairy production, fodder production, manure management and pest management and poultry farming.
The Wangari Maathai Institute for Peace and Environmental Studies' (WMI-University of Nairobi) has a more programmatic approach to support smallholder farmers. The institute works in collaboration with the University of Copenhagen in conducting need-based upscaling programs in local communities.
WMI's approach includes a need assessment in local communities, researches on relevant solutions and pairing international students with local families to apply the developed solutions. The need-based assessment addresses crop production, livestock production and environmental issues.

National and International partners facilitate projects

International partners bring in external knowledge or funds to the network. NGO's and consultancies contribute new knowledge into the network; universities collaborate in knowledge development together with their Kenyan partners.

SNV-Kenya initiated the Kenya Market-led Dairy Programme: From Aid to Trade, with funds of the Dutch Government (Rademaker et al., 2016). It also participates in the Agriculture Sector Development Support. Programme (ASDSP), led by SIDA and supported by the Swedish government. ASDSP is a value chain project in Kiambu, with the goal to change Kenya's agricultural sector into an innovative, commercially oriented, competitive and modern sector, which will contribute to improved food security, poverty reduction and equity in rural and urban Kenya, through environmental resilience, social inclusion and value chain development (Chipeta et al., 2015).

The Government of Kenya carries out the National Agricultural and Rural Inclusive Growth Project (NARIGP), with the support of the World Bank. The development objectives of NARIGP are to increase agricultural productivity and profitability targeting rural communities in selected Counties, and in the event of an Eligible Crisis to provide immediate and effective response in case of emergency. NARIGP plans projects in 21 counties, in which CSA has an important role (Ministry of Devolution and Planning, 2016).

CSA practices in NARIGP:
Increased productivity: using more inputs, innovations and improved practices.
Resiliency: efficient use and better management of soil and water resources.
Reducing greenhouse gases: better management of manure, crop residues and promotion of agro-forestry.

Government of Kenya

In its strategic plans, the Government of Kenya expresses that it aims at transforming its agricultural system to make it more productive and resilient while minimizing GHG emissions under a changing climate.
The ministry's CSA strategy plan 2017-2026, identifies four strategic areas (Government of the Republic of Kenya, 2017):
(1) Adaptation and building resilience towards extreme weather events and unsustainable land/water management and utilization;
(2) Mitigation of GHG's emissions from key and minor sources in the agriculture sector;
(3) Establishment of an enabling policy, legal and institutional framework;
(4) Minimizing effects of underlying cross-cutting issues such as human resource capacity and finance.
The Government will set up an inter-governmental coordination structure and organize funds, the implementation of the CSA strategy will be mainly by the County Governments.

Perspective from Kiambu dairy farmers

The sub-sector is dominated by small-scale farmers keeping exotic dairy breeds (Omore et al., 1999), estimated at 1.8 million farmers and 500 large-scale farmers. These smallholder dairy farmers produce 56% of the total milk produced and 80% of the total milk marketed (Omore et al., 1999).

Marketing and markets are key issues due increased commercialization of agriculture products. About 40 percent of agricultural products are lost due unsuitable storage conditions. The investment environment and business are conductive but farmers as well stakeholders have insufficient knowledge on value addition technologies (Ministry of Agriculture, Livestock and Fisheries, 2014). A major constrain to agricultural production in Kiambu is access to credit by farmers. The hindering factors include business-associated risks, land tenure systems and infrastructure.

A focus group interview with five farmers and five extension officers provided insight in the barriers for farmers in implementing CSA practices. The focus group mentioned several barriers: aging farmers, no succession plans, poor facilitation, and an individualist approach, which causes scale problems such as milk storage. The informal market controls 80% of the milk produced while the formal market controls 20%. Consumption of milk and dairy products and prices are low and most farmers prefer to invest in real estate development rather than dairy.

Scaling up CSA practices as an organizational challenge

The challenge for the Kenyan dairy sector is to combine scaling up CSA practices with inclusiveness with respect to women, youth and smallholders. This practice brief gave an impression of all different types of organizations that together, have the knowledge and means to implement this innovation. In his many articles Carayannis (Carayannis et al., 2012) outlines the development from knowledge production and innovation in the economy, which requires close collaboration between education & research and the private and public sector, towards societal innovation. Adding the goal of inclusiveness to CSA goals therefor requires adding civil organizations thus, transforming the 'triple helix' to a 'quadruple helix'.

Organizing the quadruple helix

For a knowledge network to be successful in supporting innovations and scaling up all quadruple helix partners will have to be included, have specific roles and will all benefit. Knowledge institutes for developing new knowledge in co-creation with stakeholders and educating students, governments for coordination, funding and creating enabling policy, awareness and legislation, civic partners for ensuring societal acceptation, international partners for linking with the state-of-the-art global knowledge and farmers and entrepreneurs to implement the CSA practices in their value chains and business models.

Capacity building is crucial

New technological and organizational challenge also require new competences. Capacity building and competence development at all participants therefore is a
key factor to success. Improvement of extension officers and lecturers to update their knowledge on CSA and innovation processes. Train farmers, government officials and entrepreneurs and innovate regular curricula. Facilitate extension officers with training material through a central online platform where they can download manuals, brochures and pamphlets.

Push and Pull factors

Developing innovative CSA practices, creating awareness, training and legislation are all 'push' factors for climate smart agriculture. Farmers mentioned the structure of the dairy value chain, the division of margins throughout the chain and milk prices as important barriers. These aspects are 'pull' factors. Therefore, advocated CSA practices should also strengthen 'pull' factors, by showing how they lead to a higher income of smallholder dairy farmers.

References

- Carayannis, E.G., Barth, T. D. and David F J Campbell, 2012. The Quintuple Helix innovation model: global warming as a challenge and driver for innovation.
- *Journal of Innovation and Entrepreneurship* 2012, 1:2
- Chipeta, S., Henriksen, J., , Wairimu, W., Muriuki H. and Marani M. (2015). Agricultural Sector Development Support Programme (ASDSP), Mid Term Review, Stockholm: SIDA.
- Government of the Republic of Kenya, 2017. *Kenya Climate Smart Agriculture Strategy-2017-2026*. Nairobi: Government of Kenya.
- Ministry of Devolution and Planning, 2016. *National Agricultural and Rural Inclusive Growth Project (NARIGP). Environmental and social management framework.* Nairobi: Government of Kenya.
- Ministry of Agriculture, Livestock, Fisheries and Irrigation, 2018. *Kenya Climate Smart Agriculture Implementation Framework 2018-2027*. Nairobi: Government of Kenya.
- Ministry of Agriculture, Livestock, Fisheries and Irrigation, 2014. *Household Baseline Survey Report Kiambu County (2014): Agricultural Sector Development Support Programme (ASDSP)(Rep.).* Nairobi: Government of Kenya.
- Omore, A., Muriuki, H., Kenyanjui, M., Owango, M. and Staal, S., 1999. *The Kenya dairy sub-sector: a rapid appraisal.* Smallholder Dairy (Research & Development) Project Report. Nairobi: ILRI
- Rademaker, I.F., Koech. R.K., Jansen, A., Van der Lee, J., 2015. *Smallholder Dairy Value Chain Interventions; The Kenya Market-led Dairy Programme (KMDP) – Status Report.* Report CDI-16-018. Wageningen: Wageningen UR Centre for Development Innovation.

Table 1. *Quadruple helix partners in the knowledge network addressed in this research*

	Location (town-county)	**CSA practices-specific attention**
Universities & TVETs		
Ahiti Ndomba College	Kerugoya (Kirinyaga)	Animal Ecology
Baraka Agricultural College	Molo (Nakuru)	Sustainable Agriculture and Rural development program
Naivashia College- Dairy Training Institute	Naivasha (Nakuru)	Environmental sciences course
Egerton University	Njoro (Nakuru)	All production courses
University of Nairobi- Wangari Maathai Institute of peace and Environmental studies	Nairobi (Nairobi)	Research based on need assessments with local communities.
University of Nairobi- Institute of Climate Change and Adaptation	Nairobi (Nairobi)	CSA courses and up-scaling activities in communities.
University of Nairobi University- Animal production	Nairobi (Nairobi)	Not known
Consultancy/NGO's – (inter)national		
Netherlands Development Organization (SNV) (Dutch)	Nairobi (Nairobi)	Collaborate with TVETs and cooperatives, training and advice, biogas project, Kenya Market-led Dairy Programme.
AgriProFocus (Dutch)	Nairobi (Nairobi)	Building partnerships and networks.
Perfometer (Kenyan)	Nairobi (Nairobi)	Training and consultancy,
International Livestock Research Institute (ILRI)	Nairobi (Nairobi)	Projects on low emissions, mitigation, and adaptation.
Governmental		
Ministry of Livestock production- Kiambu County	Thika (Kiambu)	Restructuring and transition of trainings to county level
Climate and Environment unit in County Ministry of Water, Environment & Natural Resources	Ruiru (Kiambu)	Established in 2018, promotion and training, curricula public schools, in collaboration with social and private partners.
Ministry of Agriculture, Livestock and Fisheries	Nairobi (Nairobi)	Implementation of strategy with international partners (f.e. ASDSP-SIDA-Sweden, NARIGP and CSAproject –World Bank).
Kenya Agricultural Livestock Research Organization	Nairobi (Nairobi)	Research coordination, projects in counties and training. International collaboration.

Climate smart dairy practices in Githunguri Dairy Farmers Cooperative Society Ltd, Kiambu, Kenya

Allen Kiiza, Marco Verschuur, Rik Eweg, Robert Baars, Honour Shumba, Catherine Wangila

Practice Brief
CSDEK Project 2019-07

CSDEK = Inclusive and climate smart business models in Ethiopian and Kenyan dairy value chains

Estimations from FAO & New Zealand Agricultural Greenhouse Gas Research Centre (2017) indicate that the GHG profile for dairy cattle is dominated by methane (CH4) followed by nitrous oxide (N_2O) and carbon dioxide (CO_2) which contribute for 95.6%, 3.4% and 1% respectively. From the methane produced, approximately 88% of the emissions arise from the rumination of cows (enteric fermentation), 11% from the management of stored manure and 1% from feed production.

The aim of this study was to identify best practices in climate change mitigation in smallholder dairy value chain in order to develop interventions for scaling up of dairy practices that support low-emission dairy development.

The study was carried out on smallholder dairy farmers belonging to Githunguri Dairy Farmers Cooperative Society Ltd., Kenya. A purposive simple random sampling technique was used to identify 48 smallholder dairy farmers in Githunguri (24) and Ruiru (24) Sub counties. Research methods such as desk study, survey, focus group discussion and observation were applied. Research tools including a structured questionnaire and checklists were used to extract data from respondents.

Githunguri Dairy Farmers Cooperative Society

Githunguri Dairy Farmers Cooperative Society Ltd. is considered one of the most successful cooperatives in Kenya. It is located in Githunguri sub county, Kiambu County, 50 Kilometres North of Nairobi City. The Cooperative was formed in 1961 by 31 smallholder dairy farmers as an initiative to help the smallholder dairy farmers of Githunguri Division, to market their milk. Over the years the cooperative increased its membership to currently 24,936 smallholder dairy farmers.

The society has 58 store outlets spread in the catchment area for the provision of animal feeds, animal health products, dairy farm implements and basic human consumables like sugar, salt, rice, corn flour among others. These items are sold to members either cash or on credit against their produce which is recoverable during monthly milk payments.

All dairy farmers visited practice zero grazing in structures with concrete floor and iron sheet roofs. Both men and women were involved in dairy production practices with female doing more of the daily work like ensuring availability of feeds and water for livestock as well as cleaning the cow barn while men made majority of the decision regarding resource allocation. Farmers in Githunguri Subcounty keep 9.2 dairy cattle of which 5.0 cows in milk. Milk production varies per household, with peak milk production per cow varying between 8 to 35 litres of milk per day.

The cooperative has 82 collection centres and 7 cooling centres spread over the catchment area. It collects between 200,000 to 300,000 kg of fresh milk per day from its members. The milk collection centres are strategically located within 500 meters distance from members' homes. The main means of milk transport to the collection centre is on foot with milk cans carried in the wheel barrows or milk trolleys. Milk collection is usually carried out twice per day i.e. in the morning from 5am to 9am and in the afternoon from 3pm to 5pm to ensure that all morning and afternoon milk is collected and processed to reduce milk wastage.

At the collection point, simple milk tests such as organoleptic tests, lactometer tests and alcohol test are performed before being transferred to the 50 litre milk cans for transportation to the processing plant. Non-conforming milk is rejected and the respective farmers are notified of the reasons for milk rejection. Most common cases of milk rejection are due to mastitis infected milk. Cases of milk adulteration are rare. If adulteration is reported, a farmer is fined 20,000 Kenya shillings. If reported for the second time, then the farmer is expelled from the cooperative.

Milk collection at collection centres lasts about 1 hour and milk is transported within the shortest time possible to the cooling centres or directly to the processing plant depending on the route. The cooperative contracts private milk transporters, but also owns cold chain mobile milk tanks. Milk prices fluctuate according to seasons ranging between 35 to 45 KSh. In August 2018, farmers are paid for a litre of fresh milk at 38 Kenya shillings.

In 2004, the cooperative installed its own milk processing plant to embark on value addition by processing and marketing its own dairy products under the flag ship of Fresha Dairy Products. The cooperative has a daily processing capacity of 300,000kg of milk while an average of 230,000kg of milk are processed per day (GDFCS, 2018). The cooperative has strategic partnerships with Brookside and New KCC to supply excess milk beyond the processing capacity but also in cases when there is a breakdown in the processing plant to ensure that farmers' milk is not wasted.

The cooperative processes and markets a range of milk products including whole milk (both fresh and long life), yoghurt, ghee, butter, lala (fermented milk) and cream (GDFCS, 2018). These products are packed in pouch packs of 200ml, 500ml; tetra pack 500ml; as well as plastic containers of 2lts and 5lts respectively. The cooperative also processes bottled water (figure 2).

Figure 2. *Fresha dairy products presented at ESADA conference, Nairobi.*

The cooperative operates wholesale outlet stores distributed across the country including Kiambu town and Nairobi city. Customers for the Githunguri dairy products include internal customers such as the staff and cooperative members while external customers include consumers, distributors, retail outlets, as well as institutions such as schools and hospitals (see figure 1).

The cooperative operates as a business hub by availing a wide range of inputs and services to smallholder dairy farmers who in turn supply milk to the cooperative as shown in figure 2.

Climate Smart Dairy Practices

The study found out that over 90% of respondents were not aware about climate change and climate smart agriculture, however

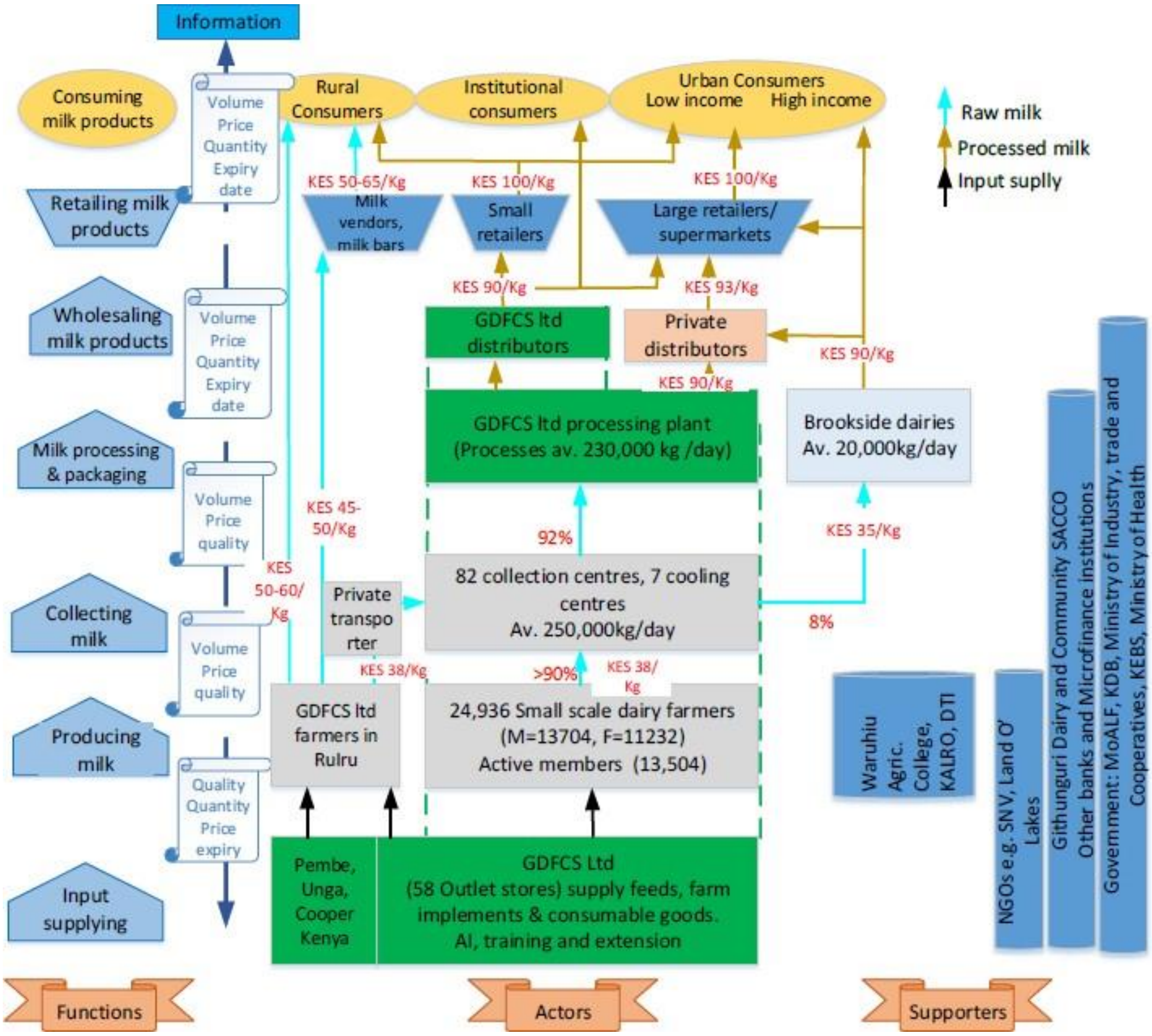


Figure 1. *Githunguri DFCS value chain map*

it was noted that farmers were already implementing practices that contributed to climate change mitigation. Practices were identified such as use of high productive dairy breeds (Friesian cattle) and use of conservation agriculture practices like mulching, intercropping, use of cover crops, agroforestry. Also identified were use of emission free means to deliver milk like milk trolleys and bicycles and use of emission free technologies like electric driven chuff cutters, electric water pumps. Table 1 shows current practices contributing to climate smart dairy production, according to the six smartness categories (water, soil, carbon, nitrogen, weather and knowledge smartness). Those categories are adapted from a format developed by World Bank and CIAT (2015). It was also noted that both men and women were involved in implementing climate smart practices. Women were more involved in daily activities, while men were more involved in decision making and resource allocation.

It was observed that 85% of farmers practiced conservation agriculture, 100% of farmers kept improved dairy breeds mainly Friesian and also provided concentrates to increase milk yield. All farmers grew high yielding and drought resistant fodder such as Napier, which is chopped before submission. However, there was limited diversification in terms of forages planted on the farm (see figure 3 and 4).

Figure 3. *Fresh stored feeds*

Over 65% of farmers utilized crop residues such as maize stovers as feeds. Overall, 85% of farmers reported that they had adequate fodder for the animals in the wet season. Conversely in the dry season, 75% of farmers indicated that they experienced fodder shortage, which highlighted the need to engage in fodder conservation practices such as hay and silage making. In times of fodder scarcity, 70% of farmers in Githunguri Subcounty indicated that they bought feed from the cooperative stores and agrovet shops. They also highlighted that feeds supplied through the cooperative stores were of good quality as compared to those bought in other agrovet shops.

Figure 4. *Chopped feeds*

Water was made available for cattle at all times through effective water harvesting means either manually or using electric water pumps to draw water from shallow wells which were located within the household compound.

Figure 5. *Manure application in the field*

Over 65% of farmers applied manure back to crop and fodder fields contributing less need for purchased inorganic fertilizers. Composting and biogas production were only adopted by less than 20% of farmers (see figure 5 and 6).

Figure 6. *Biogas application*

The study discovered the main barriers to adoption of climate change mitigation practices were limited awareness as well as insufficient funds to adopt some of the technologies such as biogas production.

To address these challenges, primary focus should on creating awareness about climate change and the importance of climate smart diary production. This can be done through production and dissemination of Information, Education and Communication (IEC) materials to farmers, use of mass media communication such as radio, television and newspaper advertisements as well as use of social media like Facebook and WhatsApp messages targeting farmers in the study area. Training of extension officers on CSA practices will help to further cascade CSA trainings to the farmers. Cost sharing (co-funding) or ensuring subsidized CSA products/services and technologies will help to increase adoption of these products and technologies among farmers.

References

- Allen Kiiza, 2018. Scaling Up Climate Change Mitigation Practices in Smallholder Dairy Value Chains: A case study of Githunguri Dairy Farmer Cooperative Society Ltd, Kiambu County, Kenya. Thesis Master Agricultural Production Chain Management.
- FAO & New Zealand Agricultural Greenhouse Gas Research Centre, 2017. Options for low emission development in the Kenya dairy sector
- reducing enteric methane for food security and livelihoods. Rome. 43 pp
- GDFCS, 2018. Githunguri Dairy Farmers Cooperative Society Homepage, available from: https://www.fresha.co.ke/content.php?com=1 &item=1> Accessed on 30 May, 2018.
- World Bank and CIAT, 2015. Climate-Smart Agriculture in Kenya. CSA Country Profiles for Africa, Asia, and Latin America and the Caribbean Series. Washington D.C.: The World Bank Group.

Table 1. *Current practices contributing to climate smart dairy production*

Smartness category	Indicators	Climate change mitigation practices identified
1. Water smartness	1.1 Allows reduction in the volume of water consumption per unit of product (food).	1.1.1 Use of high productive dairy cattle breeds
	1.2 Enhances water and moisture retention in soils (mm/m, %).	1.2.1 Mulching, use of cover crops, minimum tillage
	1.3 Promotes protection/ conservation of hydric sources (especially headwaters).	1.3.1 Agroforestry, zero grazing
	1.4 Promotes water capture/ use of rainwater for agricultural production.	1.4.1 Rain water harvesting, irrigation
2. Energy smartness	2.1 Allows for reduced consumption of fossil energy (reflected by savings in fossil fuel combustion, or electric energy consumption [J/kg, J/h, etc.])	2.1.1 Use of milk trolleys and wheel barrows for transporting milk, use of electric driven chuff cutters and water pumps
	2.2 Promotes the use of renewable energy sources (e.g. wind and/or solar energy, biogas, etc.)	2.2.1 Biogas production
3. Carbon smartness	3.1 Increases above- and below-ground biomass (ton/ha; kg/m2 etc.). This is related to the mitigation pillar in terms of carbon dioxide (CO2) capture (plant biomass, wood etc.).	3.1.1 Agroforestry, crop rotation
	3.2 Enhances the accumulation of organic matter in soils (soil carbon stock) (Soil Organic Carbon (SOC) or Soil Organic Matter (SOM).	3.2.1 Mulching
	3.3 Reduces soil disturbance (reflected in number of hours of tractor labour, application of alternative soil management techniques, etc.). Refers to the mitigation pillar in terms of CO2, reducing carbon emissions (mainly emissions associated with tillage process)	3.3.1 Conservation tillage, use of cover crops
4. Nitrogen smartness	4.1 Reduces the need of synthetic nitrogen-based fertilizers (e.g. kg/ha/year)	4.1.1 Application of manure in crop fields, grass-legume intercropping
	4.2 Reduces nitrous oxide (N2O) emissions (by adopting better techniques of fertilizers use and soil management practices). Reflected in, for instance, reductions in number of grams of N2O/m2/year.	4.2.1 Apply right quantities on fertilizers
5. Weather smartness	5.1 Minimizes negative impacts of climate hazards (such as soil degradation, effects of flood or prolonged drought events among others).	5.1.1 Agroforestry 5.1.2 Seasonal management of cow herd numbers
	5.2 Helps prevent climatic risks (refers to practices that allow farmers be more prepared to mitigate climate risks, such as water reservoirs, early warning systems, heat/, water stress- pests- and diseases- tolerant/ resistant varieties, etc.)	5.2.1 Rain water harvesting and water storage. 5.2.2 Zero grazing 5.2.3 Drought resistant fodder plants e.g. Napier 5.2.4 Use of irrigation 5.2.5 Hay and silage making
6. Knowledge smartness	6.1 Allows rescuing or validates local knowledge or traditional techniques (indigenous knowledge)	6.1.1 Mulching, contour ploughing, crop rotation

Source: Adapted from World Bank and CIAT, 2015.

Organized Farmer Groups as Pathways for Scaling up CSA Practices in Dairy Value Chains: A case of Githunguri Dairy Farmers Cooperative Society Ltd, Kiambu, Kenya

Allen Kiiza, Marco Verschuur, Rik Eweg, Robert Baars

Practice Brief
CSDEK Project 2019-08

CSDEK = Inclusive and climate smart business models in Ethiopian and Kenyan dairy value chains

van hall larenstein
university of applied sciences

Introduction

The Greenhouse Gas (GHG) profile for dairy cattle is dominated by methane (CH4) followed by nitrous oxide (N_2O) and carbon dioxide (CO_2) which contribute 95.6%, 3.4% and 1% respectively (FAO & New Zealand Agricultural Greenhouse Gas Research Centre, 2017). In Kenya, the dairy cattle sector is responsible for about 12.3 million tonnes CO_2 eq. of greenhouse gas emissions. Estimations from FAO & New Zealand Agricultural Greenhouse Gas Research Centre (2017) indicate that approximately 88% of these emissions arise from methane produced by the rumination of cows, 11% from the management of stored manure and 1% from feed production. Increase in greenhouse gas (GHG) emissions leads to climate variability and change.

A number of strategies and approaches such as Climate Smart Agriculture (CSA) are being developed and implemented by the Kenya government in collaboration with local and international partners to transform the country's dairy sector to ensure a low-emission development pathway while also improving the livelihoods of male and female dairy producers (GoK, 2017).

The aim of this study was to identify best practices in climate change mitigation in smallholder dairy value chain in order to develop interventions for scaling up of dairy practices that support low-emission dairy development. This practice brief is intended to highlight how organized farmer groups can act as pathways for scaling up CSA practices.

The study was carried out on smallholder dairy farmers under Githunguri Dairy Farmers Cooperative Society Ltd., Kenya. A purposive simple random sampling technique was used to identify 48 smallholder dairy farmers in Githunguri (24) and Ruiru (24) Sub counties. Research methods such as desk study, survey, focus group discussion and observation were applied. Research tools including a structured questionnaire and checklists were used to extract data from respondents

Githunguri Dairy Farmers Cooperative Society (GDFCS) Ltd

Githunguri Dairy Farmers Cooperative Society Ltd was established in 1961 and is located in Githunguri subcounty, Kiambu County, 50 km north of Nairobi City (AFAAS, 2013). The Cooperative was formed as an initiative to help its 31 founding members to market their milk. By 2018, the cooperative had a total of 24,936 members, however only about 13,500 members were active (those that deliver milk consistently for about 3 months). Of the total membership 52% were male while 48% were female. Members are clustered according to zones within the catchment area for effective management of the cooperative activities such as monthly trainings and extension, access to stores, as well as milk collection. The zones are subdivided into routes with each route represented by a representative who is a dairy farmer. There are 10 main routes with several sub routes under each main route. On each route are milk collection centres which are strategically located within a walking distance from the members' homes to ensure timely delivery and collection of milk at the collection points.

The cooperative has 82 collection centres and 7 cooling centres spread over the catchment area which is mainly the 5 wards of Githunguri sub county. The cooperative processes about 230,000 kilograms of milk per day (GDFCS, 2018). In 2004, the Cooperative commissioned its own milk processing plant to embark on processing and marketing of its own milk products under the flagship of Fresha Dairy Products (Muriuki, 2006).

GDFCS Ltd Service Orientation to Members

The cooperative operates as a business hub by availing a wide range of inputs and services to its members who in turn supply milk to the cooperative (Figure 1). The following services are offered by the cooperative to its members.

a) Financial services

The cooperative offers financial and credit services to members through its Savings and Credit Cooperative Organization (SACCO) called Githunguri Dairy and Community SACCO Ltd. The SACCO started in 2003 and members payments for monthly milk deliveries are effected through this SACCO to ensure proper management and timely processing and disbursement of members savings and loans.
Packages offered by the SACCO to farmers include: Salary Advance- Availed to all salaried staff; Milk Advance- Available to all dairy farmers (members); Jiunge Advance- Given to those who want to join Githunguri Dairy Society, but do not have the registration fee; Kwamua Advance- Given to members for their emergency needs; Mazao Loan- For members who channel their milk through the SACCO; Ngombe Loans- To assist farmers purchase high grade cows for better milk productivity; Biashara Loan- Empowering business community to expand their businesses.

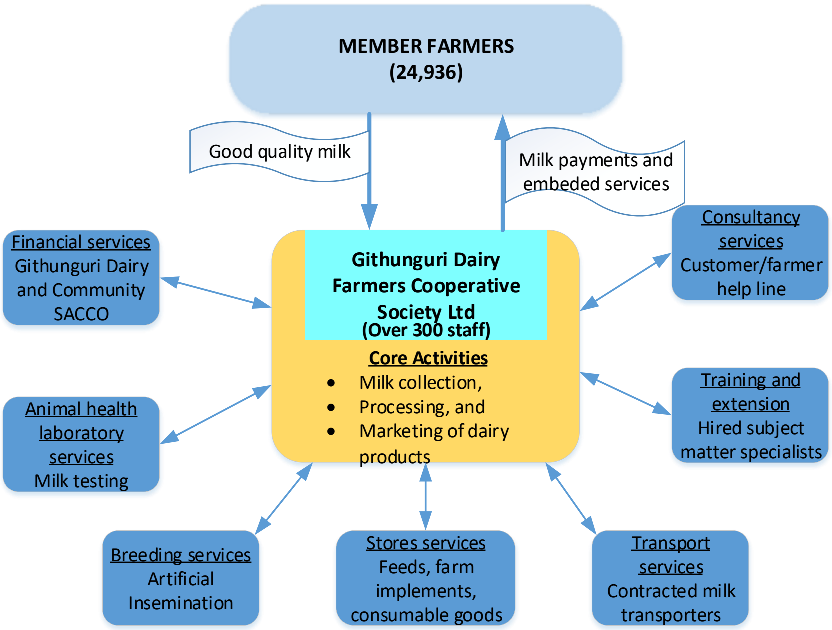


Figure 1. *Githunguri DFCS ltd business hub arrangement*
Source: Adapted from ILRI Manual (Mutinda et al., 2015).

b) IT and Customer services

To ensure proper management and efficient customer service, the cooperatives hires professionals and specialized technical members of staff to offer quality and professional business services. The cooperative uses ultramodern milk processing equipment and has embraced information and communication technology by computerizing most of its operations to ensure smooth service delivery. The cooperative has a website and a 24 hour customer helpline to effectively respond to customer queries.

c) Stores services

The cooperative provides services such as input supply for quality feeds, animal health products, farm implements and household consumables like sugar, salt, among others. Stores services are provided on non-profit basis, but are managed as cost-centres where each activity and/or store is fully accountable for its expenditure and revenue. Services to members are offered at subsidized prices on cash or credit basis. Payment of services can be effected through cash or check-off arrangement where members pay for services through deductions from monthly milk pay outs.

d) Breeding and AI services

The cooperative has a dedicated and well equipped breeding and artificial insemination unit with 7 AI technicians each with a vehicle. These respond to farmers' cases either on call or through pre-arranged farm visits. Through these services, farmers have been able to upgrade their dairy breeds.

e) Milk collection and transport services

The cooperative hires private milk transporters in addition to a fleet of cold chain milk transport trucks owned by the cooperative, to ensure that all milk produced by farmers is timely transported from the collection centres to the processing plant. This ensures that milk does not get spoilt or wasted during transportation.

f) Extension and training services

The cooperative offers training and extension services to farmers and staff. In 2018, the cooperative employed 12 extension officers and each was equipped with a motorcycle. These attend to farmers either on a case by case basis or in groups. The cooperative also seeks services of specialized facilitators (subject matter specialists) depending on the topic to be discussed. Members under every route are entitled to at least one training session per month. Topics to be trained on are agreed upon through consultations and consensus by majority farmers under a given route. Topics discussed in 2018 included modern dairy management practices, fodder management, financial management, human health and nutrition issues, among others. Facilitators are hired by the cooperative from public and private institutions including ministries such as Ministry of agriculture, livestock and fisheries, and also professional private practitioners.

Climate Smart Practices identified under GDFCS Ltd

Identification of climate smart practices in the study area was supported by use of categories of indicators as well as sub indicators related to the management and use of carbon, nitrogen, energy, weather, water and knowledge, using a set of proxies for each to evaluate climate-smartness as indicated in Table 1.

The study revealed that over 90% of respondents in the study area were not aware about climate change and/or climate smart agriculture but results indicated that smallholder dairy farmers were already implementing practices that contribute to climate change mitigation such as use of conservation agriculture practices like mulching, intercropping, use of cover crops, agroforestry; use of high productive dairy breeds like Friesian cattle; use of emission-free means like milk trolleys and bicycles to deliver milk to collection centres as well as use of emission-free technologies like electric driven feed choppers and electric water pumps, among others. The level of adoption of these practices as well as the service orientation contributing to the adoption of the various practices is indicated in Table 2.

Table 1. *Indicators of climate smartness and the various CSA practices identified under GDFCS Ltd*

Smartness category	Indicators	Climate change mitigation practices identified
1. Water smartness	1.1 Allows reduction in the volume of water consumption per unit of product (food).	1.1.1 Use of high productive dairy cattle breeds
	1.2 Enhances water and moisture retention in soils (mm/m, %).	1.2.1 Mulching, use of cover crops, minimum tillage
	1.3 Promotes protection/ conservation of hydric sources (especially headwaters).	1.3.1 Agroforestry, zero grazing
	1.4 Promotes water capture/ use of rainwater for agricultural production.	1.4.1 Rain water harvesting, irrigation
2. Energy smartness	2.1 Allows for reduced consumption of fossil energy (reflected by savings in fossil fuel combustion, or electric energy consumption [J/kg, J/h, etc.])	2.1.1 Use of milk trolleys and wheel barrows for transporting milk, use of electric driven chuff cutters and water pumps
	2.2 Promotes the use of renewable energy sources (e.g. wind and/or solar energy, biogas, etc.)	2.2.1 Biogas production
3. Carbon smartness	3.1 Increases above- and below-ground biomass (ton/ha; kg/m2 etc.). This is related to the mitigation pillar in terms of carbon dioxide (CO_2) capture (plant biomass, wood etc.).	3.1.1 Agroforestry, crop rotation
	3.2 Enhances the accumulation of organic matter in soils (soil carbon stock) (Soil Organic Carbon (SOC) or Soil Organic Matter (SOM).	3.2.1 Mulching
	3.3 Reduces soil disturbance (reflected in number of hours of tractor labour, application of alternative soil management techniques, etc.). Refers to the mitigation pillar in terms of CO_2, reducing carbon emissions (mainly emissions associated with tillage process)	3.3.1 Conservation tillage, use of cover crops
4. Nitrogen smartness	4.1 Reduces the need of synthetic nitrogen-based fertilizers (e.g. kg/ha/year)	4.1.1 Application of manure in crop fields, grass-legume intercropping
	4.2 Reduces nitrous oxide (N_2O) emissions (by adopting better techniques of fertilizers use and soil management practices). Reflected in, for instance, reductions in number of grams of N_2O/m2/year.	4.2.1 Apply right quantities on fertilizers
5. Weather smartness	5.1 Minimizes negative impacts of climate hazards (such as soil degradation, effects of flood or prolonged drought events among others).	5.1.1 Agroforestry 5.1.2 Seasonal management of cow herd numbers
	5.2 Helps prevent climatic risks (refers to practices that allow farmers be more prepared to mitigate climate risks, such as water reservoirs, early warning systems, heat/, water stress- pests- and diseases- tolerant/ resistant varieties, etc.)	5.2.1 Rain water harvesting and water storage. 5.2.2 Zero grazing 5.2.3 Drought resistant fodder plants e.g. Napier 5.2.4 Use of irrigation 5.2.5 Hay and silage making
6. Knowledge smartness	6.1 Allows rescuing or validates local knowledge or traditional techniques (indigenous knowledge)	6.1.1 Mulching, contour ploughing, crop rotation

Source: Adapted from World Bank and CIAT, 2015.

Table 2. *Level of adoption of the various CSA practices and Service orientation contributing to adoption of CSA practices.*

Mitigation measures	Practices identified	Level of adoption (% farmers)	GDFCS Ltd Service orientation contributing to the adoption of the CSA practices
1.1 Use of conservation agricultural production practices that increase soil productivity	1.1.1 Crop rotation	>60%	• Training and extension services
	1.1.2 Mixed cropping	>60%	
	1.1.3 Mulching	>60%	
	1.1.4 Agroforestry	30-60%	
	1.1.5 Terracing and contour bands	<30%	
	1.1.6 Manure application on crop and fodder plots	>60%	
1.2 Planting of improved fodder (high yielding, fast growing, draught resistant)	1.2.1 Planting of improved fodder like napier	>60%	• Training and extension services
	1.2.2 Incorporation of legume grasses like desmodium	<30%	
	1.2.3 Incorporation of fodder trees like caliandra, gliricidia	<30%	
1.3 Adoption of fodder conservation techniques	1.3.1 Hay making	30-60%	• Training and extension services
	1.3.2 Silage making	<30%	
2.1 Use of crop residues and agro industrial by products	2.1.1 Use of maize stovers, weeds, Potato vines, brewers waste	30-60%	• Training and extension services • Stores services • Financial services
2.2 Feeding more concentrates to dairy cattle to improve productivity and reduce enteric methane	2.2.1 Concentrates used included Dairy meal, Wheat bran Maize germ, Pollard Minerals supplements	>60%	
3.1 Water harvesting for dairy production	3.1.1 Use of electric driven water pumps to draw water from shallow wells	>60%	• Financial services • Training and extension services
	3.1.2 Rain water harvesting	<30%	• Training and extension services
4.1 Construction of zero grazing units	4.1.1 Cow shed ith concrete floor to ease manure collection	>60%	• Training and extension sercices • Financial services
	4.1.2 Cow shed with cow mat or straw in sleeping area to allow cow comfort		
	4.1.3 Cow shed with separate feeding and sleeping area		
5.1 Adopt and use of high yielding dairy breeds	5.1.1 Use of improved dairy breeds such as Friesian	>60%	• Breeding and AI services • Training and extension services • Financial services • IT and customer care services
	5.1.2 Use of selective breeding system (AI)	>60%	
6.1 Using solid coverage and capturing methane emissions for bioenergy use.	6.1.1 Biogas production	<30%	• Training and extension services
	6.1.2 Manure composting	<30%	
7.1 Effective milk collection system to minimize emissions	7.1.1 Milk collection centres located at walking distance from farmers	>60%	• Milk collection and transportation services • Training and extension services
	7.1.2 Use of milk transport means that do not emit GHG such as milk troleys/wheel barrows, bicycles	>60%	

Linking uptake of climate smart practices to GDFCS Ltd service orientation

The study revealed that some of the identified CSA practices were adopted by majority of farmers (over 60%) compared to others (Table 2). Farmers also cited different reasons/barriers as to why some of the practices were less adopted as highlighted in the following sections.

Conservation agriculture practices, fodder production and dairy cattle feeding

Overall, the research established that over 85% of respondents already adopted conservation agriculture practices such as crop rotation, mixed cropping, mulching, manure application to gardens and agroforestry, among others. Through discussions with farmers, it was noted that farmers have been applying these practices for a long time through local knowledge, to ensure long term sustainability of their farming enterprises. Some of these practices were mainly practiced in production of food crops such as maize, beans as well as vegetables rather than in fodder production, however, farmers indicated that the cooperative through training and extension services organizes trainings and exchange visits with other institutions like Waruhiu agricultural college where farmers are trained in different agronomical and dairy production practices.

Planting of improved fodder (high yielding, fast growing, drought resistant)

The study established that all the farmers (100%) had planted Napier grass as an improved fodder on their farms, however, other fodder plants such as Desmodium, Lucerne and other legumes were less adopted (less than 15% of respondents). Farmers indicated that Napier was fast growing, provided higher yields and is drought resistant therefore could be grown all year round to ensure availability of feeds for cattle. Farmers revealed that through training and extension services offered by the cooperative, they had been trained on the importance of fodder diversification, although it was difficult to grow all fodder varieties, because of the small plots of land that farmers owned. Interactions with the cooperative's head of extension department indicated that the cooperative together with the sub county livestock office in Githunguri were already in plans of introducing other fast growing and high yielding crops such as maize varieties which farmers could adopt for feeding livestock.

Adoption of fodder conservation techniques

Adoption of fodder conservation techniques such as hay and silage making was low as reported by less than 30% of the farmers in Githunguri, however, 96% of farmers indicated that they used hay in addition to Napier for feeding cattle throughout the year. Most of this hay was sourced from Nanyuki and the western rift valley area and sold to farmers through the various agro-vet shops in the subcounty. Farmers indicated that whereas the cooperative through the training and extension services offered trainings on hay and silage making, farmers had small plots of land where they could grow sufficient fodder for hay or silage production. Therefore such practices were considered not to be cost effective.

Use of crop residues and agro-industrial by-products

About 90% of farmers indicated that they used maize stovers to feed their cattle. Farmers indicated that the maize stovers were readily available from their gardens or more stovers were bought from neighbours who did not keep cattle. Use of other crop residues like pineapple pulp, sweet potato vines, banana pseudo-stems and weeds was reported but generally less adopted as report by less than 20% of farmers. Through training and extension services of the cooperative, farmers were trained on the use of crop residues to feed cattle to reduce on the need for planted or purchased fodder but also to help to create important synergies in crop-livestock farming systems which involves recycling of animal manure into farmland to maintain soil fertility.

***Feeding more concentrates to dairy cattle to improve productivity and reduce enteric methan*e**

All farmer respondents indicated that they used concentrates and mineral supplements for feeding their dairy cattle. This included use of concentrates such as dairy meal (as reported by all farmers), wheat bran (reported by 96% of farmers), maize germ (reported by 54% of farmers) among others, highlighting that these were of good quality and easily accessible through the cooperative stores. The main reason for feeding cattle on concentrates as reported by farmers was to increase milk production. Majority of dairy farmers were able to access high quality feed supplements through the cooperative's financial services system which allows active members to get products from the cooperative's outlet stores on credit and pay later through a monthly milk payment check-off system.

Water harvesting for dairy production

Respondents indicated that there were a number of water sources in the area including rivers, shallow wells, municipal (piped) water, community water system as well as rain water, however, over 90% of the interviewed farmers indicated that the main source of water for livestock was shallow well water, which was readily available within the home compound. Farmers used either electric powered submersible water pumps or manual means (both emission free) to draw water from the wells thus water was made available for cattle at all times. Farmers also indicated that they were able to buy water pumps through access to finances (loans) from the cooperative SAACO. Water availability also makes irrigation possible especially in the dry season, however only 29% of respondents reported to irrigate their crops with others citing high cost of the irrigation equipment as the major barrier. Some of the farmers had received irrigation equipment from previous projects.

Construction of zero grazing units

Over 75% of farmers in Githunguri and Ruiru sub counties had animal sheds with different cubicles used for animal feeding and sleeping area, roofed with iron sheets. The animal sheds had concrete floor which facilitated proper drainage and ease of manure collection. Dairy farmers indicated that they were sensitized on construction and use of proper animal sheds through trainings organized by the cooperative. Keeping cattle under zero grazing system is important for climate smartness in terms of ease of feed and manure management and also limiting cases of diseases such as mastitis which would contribute highly to post harvest milk losses.

Adoption and use of high yielding dairy breeds

All interviewed dairy farmers (100%) reported that they kept improved dairy cattle breeds under zero grazing system. The main breed of cattle kept as reported by farmers was Friesian (92%) while other breeds included Ayrshire (4%), Holstein (3%) and Friesian crosses (1%), no farmer reported to keep local cattle (Zebu). The study also indicated that the average milk yield produced by farmers in Githunguri sub county was 21 litres per day while in Ruiru sub county it was 16 litres per day. All interviewed farmers indicated that they used AI method to improve their dairy breeds which they reported to be reliable and readily available through AI department of the cooperative. Farmers desiring to purchase high grade cows for better milk productivity were able to access Ngombe loans provided by the Cooperative SACCO. Keeping highly productive dairy breeds is important for climate change mitigation since higher productivity means using less input for the same amount of output, consequently generating less waste, including greenhouse gases.

Using solid coverage and capturing methane emissions for bioenergy use

Only 15% and 17% of farmers reported to have adopted composting and biogas production respectively. The major barriers to adoption of proper manure management techniques were limited awareness on proper manure management methods as well as high cost of some of the technologies such as biogas production. It was noted that majority of farmers collected and heaped manure outside the cow barn or by the roadside in open air without any form of covering. Heaping manure in open air where it is exposed to heat and rain contributes to nutrient losses especially through ammonia volatilization hence reducing nitrogen content, therefore the training and extension services department of the cooperative needs to conduct more trainings in this regard with special attention to minimizing GHG emissions.

Effective milk collection system to minimize emissions

In terms of milk transportation to collection centres, over 60% of farmers had adopted use of emission-free mean like trolleys and bicycle. This was possible, because the cooperative through its milk collection and transportation services had established 82 collection centres and 7 cooling centres which were strategically located within a walking distances from farmers' homes, which were on average less than 500 meters.

Scenarios for scaling-up adoption of CSA practices under GDFCS Ltd

There are several ways how CSA practices can be scaled up under GDFCS Ltd.

i) CSA products and services paid for by cooperative and individual farmers. This kind of model depicts a situation where the cooperative and individual farmers pay for different Climate smart packages (Figure 2).

Scenario 1: This scenario depicts a situation where the cooperative (Funder 1) pays for CSA services on behalf of farmers. The Cooperative may hire CSA service providers to offer training packages on climate change mitigation interventions to its farmers.

Scenario 2: Depicts a situation where farmers (Funder 2) pay for products and services through milk deliveries to the cooperative. It is believed that once farmers have been sensitized in the different climate smart agriculture packages, some farmers may want to adopt some of the technologies such as biogas technology.

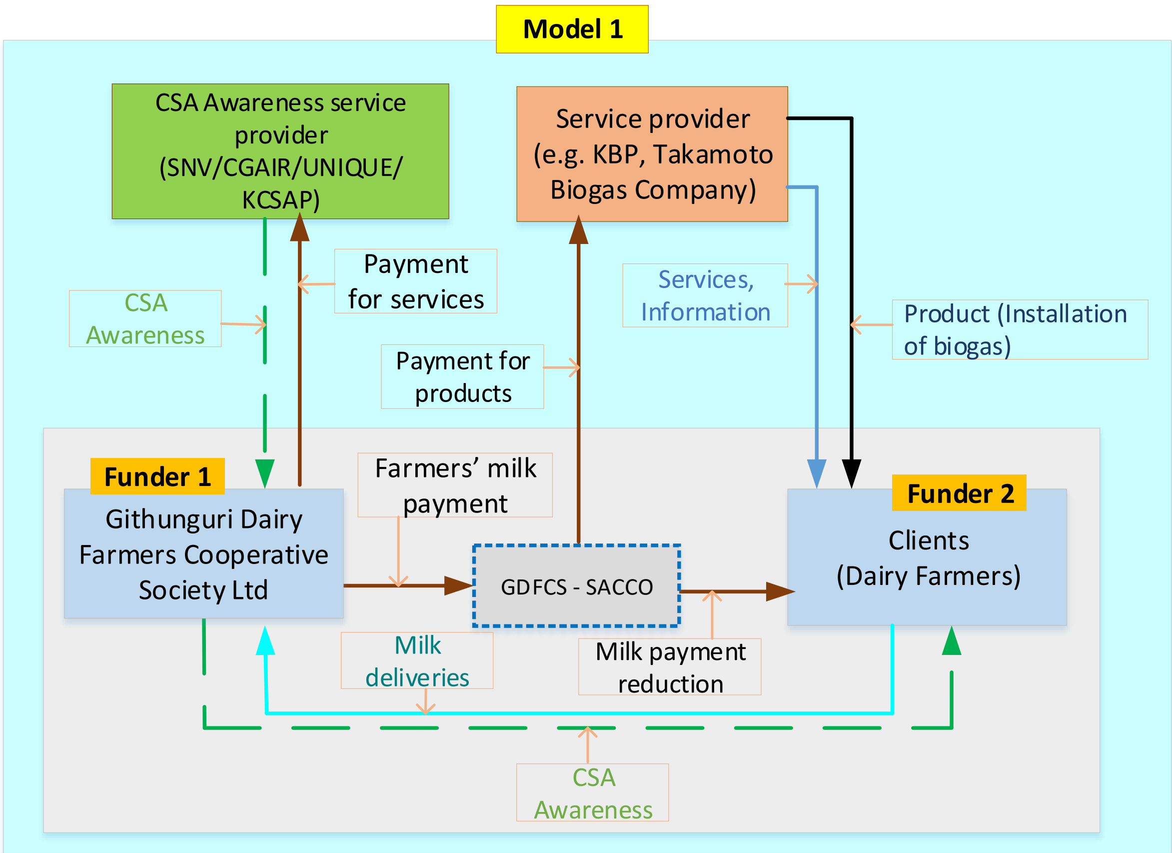


Figure 2. *CSA services and products paid for by cooperative and individual farmers*

ii) Fully paid or subsidized (partial paid) products and services by Government or Development partner. The second model (Figure 3) depicts a situation where there is an external source of funding provided by promoters of climate change mitigation actions/climate smart agriculture such as the Government of Kenya or a Development partner such as IFAD or FAO. Three scenarios are identified for this kind of model.

Scenario 1: Depicts a situation where Government or the Development partner (IFAD, FAO etc) as CSA promoting agencies may facilitate sensitization of farmers on climate smart agriculture through CSA service providers such as SNV, UNIQUE Agroforestry and Land Use, KCSAP, among others. By collaborating with the cooperative, the CSA service providers will be able to reach out and sensitize dairy farmers on climate smart dairy production.

Scenario 2: Depicts a situation where there is partial payment for CSA product and services by Government or Development partner. In this scenario the government or development partner may want to provide co-funding for farmers to adopt some of the CSA practices and technologies. Government or development partner will channel the co-funding through the Cooperative's SACCO. Also interested dairy farmers will be required to provide co-funding through milk deliveries to the cooperative. An appropriate service provide will be contracted by the cooperative in collaboration with the funding agency to offer CSA products and services to farmers.

Scenario 3: Depicts a situation where Government or Development partner fully pays for CSA products and services to the service providers on behalf of farmers. In this case, Government or Development partner identifies and pays a suitable CSA service provider such as KBP or Takamoto biogas company to install CSA technologies on behalf of farmers. The CSA service provider collaborates with the cooperative to effectively reach out to farmers and provide CSA products and services.

References

- *AFAAS, 2013.* AFAAS Agricultural extension week: Githunguri Dairy Farmers Cooperative Society Ltd. African Forum for Agricultural Advisory Services (AFAAS) blog post, August 2013. Available from: <http://afaas-africa.blogspot.com/2013/08/ githunguri-dairy-farmers-co-operative.html>. Accessed on 31 May, 2018.
- *Allen Kiiza, 2018.* Scaling Up Climate Change Mitigation Practices in Smallholder Dairy Value Chains: A case study of Githunguri Dairy Farmer Cooperative Society Ltd, Kiambu County, Kenya. Velp, Netherlands: Thesis Master Agricultural Production Chain Management.
- *FAO & New Zealand Agricultural Greenhouse Gas Research Centre, 2017.* Options for low emission development in the Kenya dairy sector - reducing enteric methane for food security and livelihoods. Rome. 43 pp
- *GDFCS, 2018.* Githunguri Dairy Farmers Cooperative Society. Homepage, available from: https://www.fresha.co.ke/content.php?com=1&item=1 > Accessed on 30 May, 2018.
- *GoK, 2017.* Kenya Climate Smart Agriculture Strategy-2017-2030. Ministry of Agriculture, Livestock and Fisheries
- *Muriuki H. G., 2006.* A Dairy Co-operative Society. Lessons in Dairy Development – Case Studies. Animal Production and Health Division, Food and Agriculture Organisation (FAO).
- *Mutinda, G., Baltenweck, I. and Omondi, I., 2015.* Setting up sustainable dairy business hubs: A resource book for facilitators. ILRI Manual 21. Nairobi, Kenya: International Livestock Research Institute (ILRI).
- *World Bank and CIAT, 2015.* Climate-Smart Agriculture in Kenya. CSA Country Profiles for Africa, Asia, and Latin America and the Caribbean Series. Washington D.C.: The World Bank Group.

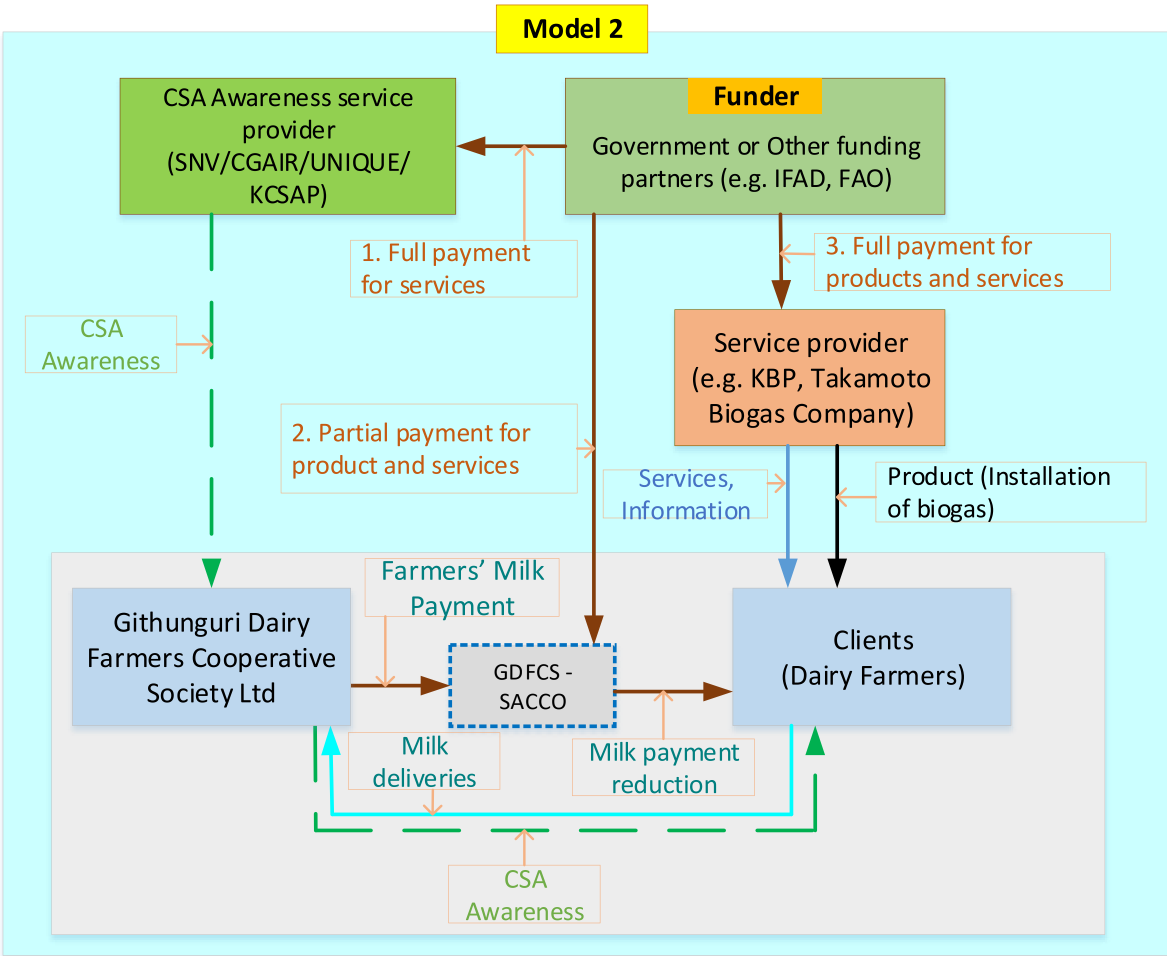


Figure 3. *Fully paid or subsidized (partial paid) products and services by Government or Development*

Climate smart agriculture interventions in small holder dairy feed value chain in Githunguri and Ruiru Sub-county, Kiambu county, Kenya

Honour Shumba, Marco Verschuur, Rik Eweg, Robert Baars, Allen Kiiza, Catherine Wangila

Practice Brief
CSDEK Project 2019-09

CSDEK = Inclusive and climate smart business models in Ethiopian and Kenyan dairy value chains

van hall larenstein
university of applied sciences

Climate change has caused dilapidation of the environment, droughts and floods leading to reduced yields, productivity and ultimately feed insecurity. Hence this research aimed to unravel farmer's knowledge on climate smart agriculture, his performance on the dairy feed production and to discuss mitigation options for greenhouse gas emissions.

Research approach

The research project has a value chain approach. Initially we had a focus group discussion with farmers. This was followed by a survey of 15 farmers from Ruiru and 27 farmers from Githunguri.dairy farmers cooperative society (GDFCS, 2018) (see picture 1). Snow ball sampling and random sampling were used for the two sub- counties respectively. Household survey data are used, complemented by qualitative information from focus group discussions and key informant interviews. Case study was also conducted on plots for gross margin analysis of feed production.

Feed Value Chain

Smallholder dairy farmers in Githunguri and Ruiru are producing feed on very small pieces of land. Their dairy farming systems are Napier based, as promoted by Kenyan Dairy Development Programmes (FAO, 2011; Gatchuiri et al., 2012). Dairy farmers are concentrating on feed production and they are not aware of the implications of their actions on climate change.

The main problem is insufficient production of quality dairy feed. The main causes are; Inadequate land size, low herbage production, inexplicit land tenure system, low soil fertility and expensive feed supplements. The main effects are increased use of fertilisers, increased methane production and reduced seasonal milk production leading to increased green-house gas emissions and reduced farmer income.

Picture 1. *Interview with female dairy farmer*

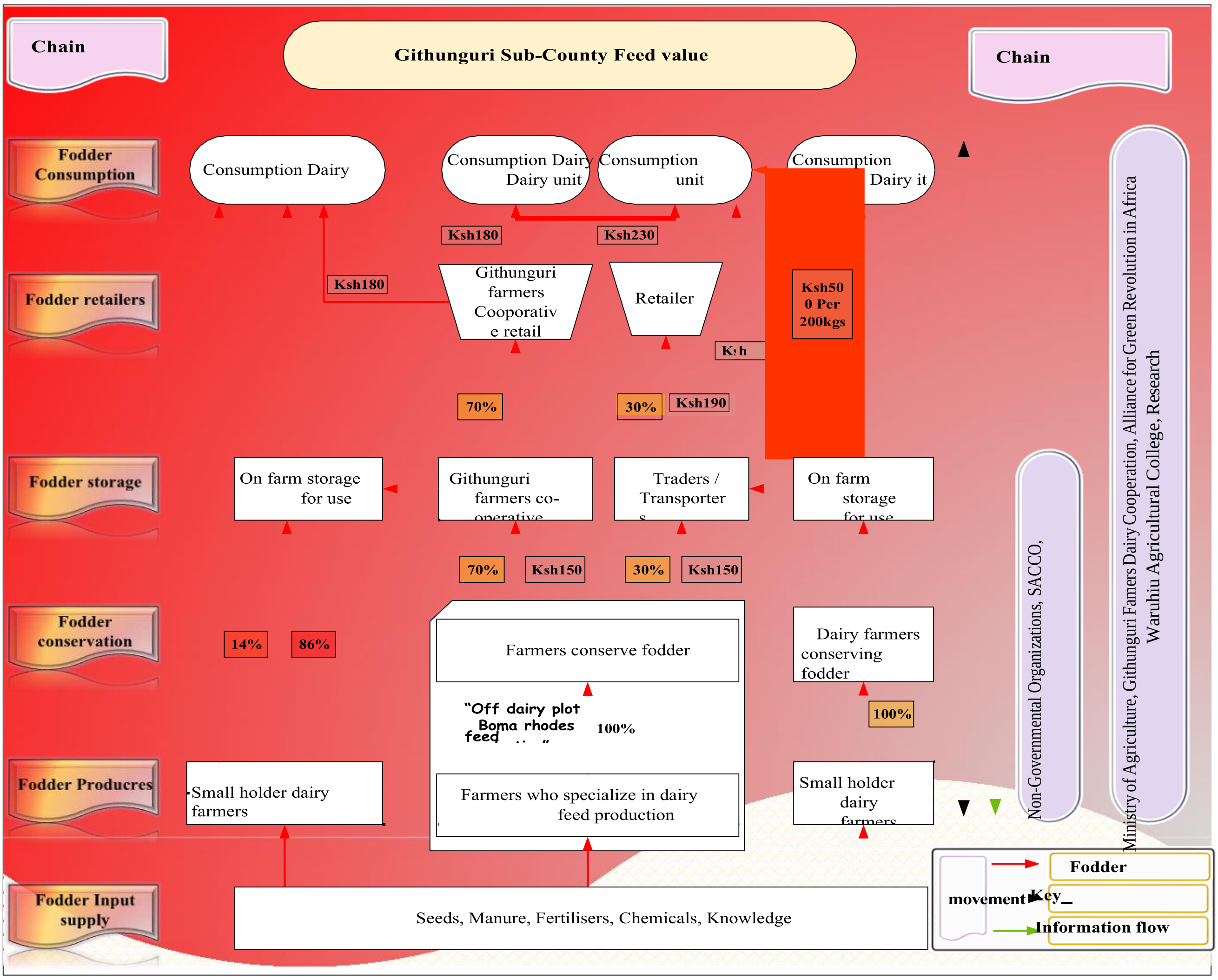


Figure 1. *Feed value chain in Githungury*

The Feed Value Chain found in Githunguri is shown in figure 1. GDFCS provides feed supply services to farmers and it has a legal contract with farmers. However, there are notable differences between Githunguri and Ruiru sub- counties. The plot sizes of dairy farmers are small, averaging 1.6 acres. The number of dairy cattle average 7 and 3 for Githunguri and Ruiru respectively.

The transport means for getting fresh forage to the zero grazing units are with donkey cart, lorry and motocycle (see picture 3).
Most of family labour is being provided by women. However, women and youths are marginalised in decision making of the dairy units. Youth participation is below 14%.

Climate Smart Agriculture Practices

It is noted that farmers are focusing on productivity of fodder and giving less concentration to climate smart agriculture. The climate smart agricultural practices include agroforestry, minimum tillage, zero grazing, crop rotation, water harvesting, manure management, energy usage and soil analysis (see table 1).
Table 2 shows the percentage of interviewed farmers implanting these practices.

Farmers mostly prefer Napier grass and Boma Rhodes hay as feed sources (table 3), because of the nutritious value and availability (picture 2). Moreover, it is labour extensive, if cut it rejuvenates on its own; it is suitable for the cut and carry system. Table 4 shows famers' strategies to cope with feed shortage during periods of low feed availability, ranked in order of importance. Farmers prefer feeding silages or crop residues, although they realise the high cost and the low digestibility respectively.

Wheat straw @ KES110 & Boma Rhodes @ KES 180

Picture 2. *Sale of Wheat straw & Boma Rhodes*

Table 5 shows the percentage of farmers using alternative concentrate feed sources.

Feed chain governance

According to the model of Gereffi et al. (2005), the feed governance of GDFCS is both market and modular governance (Gereffi et al, 2005).

Githunguri dairy farmers have a modular governance system, since the GDFCS secures feed for them and which they can get from its retail outlets. The farmers have a binding contract with the cooperative for milk production value chain hence the benefits are emanating from there. GDFCS however has a market type of governance with the feed suppliers, since it buys feed from travelling traders upon negotiating for price and ascertaining the quality of feed they want. It is prudent that the cooperative deal with feed the same way it deals with milk. Transition of feed chain governance from market to modular is a way of securing quality feed for all farmers.

For securing the quality feed sources and reducing GHG-emissions, there is need of sustainable production of feed at household level and reduction of feed purchase from unscrupulous retailers/traders. For a modular governance system, GDFCS can introduce fodder maize, that is climate smart, cheaper and affordable for farmers and train them on production and silage making processes.

Picture 3. *Feed transportation means*

Table 1. *climate smart agricultural practices*

Crop management	**Livestock management**	**Soil and water management**	**Agroforestry**	**Integrated food energy systems**
• Intercropping with legumes • Crop rotations • New crop varieties (e.g. drought resistant) • Improved storage and processing techniques • Greater crop diversity	• Improved feeding strategies (e.g. cut 'n carry) • Fodder crops • Grassland restoration and conservation • Manure treatment • Improved livestock health • Animal husbandry improvements	• Conservation agriculture (e.g. minimum tillage) • Contour planting • Terraces and bunds • Planting pits • Water storage (e.g. water pans) • Pits, ridges • Improved irrigation (e.g. drip)	• Boundary trees and hedgerows • Nitrogen-fixing trees on farms • Multipurpose trees • Woodlots • Fruit orchards	• Biogas • Improved stoves

Table 2. climate smart agriculture practices implemented in Githunguri

	Climate Smart Agriculture practices/indicators													
	Zero grazing		Agroforestry		Crop rotation		Minimum tillage		Water harvesting		Soil analysis		Fertiliser usage	
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Githunguri	93%	7%	78%	22%	37%	63%	89%	11%	59%	41%		100%	41%	59%
Ruiru	100%		80%	20%	27%	73%	87%	13%	67%	33%		100%	13%	87%

Table 3. *Farmer's perception on hay*

Feed	Preference	Perception
Napier	High	It's readily available, requires less labour and its perennial
Green maize stover	Low	It's not readily available and farmers prefer storing stover for periods of feed scarcity
Dry maize stover	Medium	It can be stored and used when feed is in short supply but it's less nutritive. Thus, it does not add value to milk productivity and quality of milk
Rhodes grass bales	High	They are considered the best but the buying price makes farmers shy away from them.
Wheat bales	Low	They are not always readily available
Lucene bales	Low	They are not readily available and they are costly for the farmers

Table 4 . *Strategies by farmers to cope with feed shortage during periods of low feed availability**

Strategy	**Strength**	**Weakness**	**Climate smartness**
Feed on conserved feed e.g. silage	Ensures feed security on plot	It's expensive for farmers	It ensures quality feed hence it's climate smart
Feed on crop residue e.g., maize stover	Very cheap for farmers	Crop residue not readily available	Digestibility is low hence increases GHG emissions
Buying feed from traders/ GDFC e.g. hay	Ensures feed availability on plot	It's expensive for farmers	Quality is not certain hence digestibility leads to GHG emissions
Buying concentrates	Ensures a constant milk production trend and it's highly digestible	It's expensive for farmers	Its climate smart but does not promote circularity of nutrients
Harvesting grass from public land, river banks and neglected coffee plantations	Very cheap for farmers	Predisposes animals to tick borne infections and helminths	Quality of hay is compromised hence promoting excessive GHG emissions due to low digestibility
Grazing on the forestry area	Forestry commission charges are affordable	Dairy cattle are prone to mastitis, tick borne infections and helminths	Feed quality cannot be monitored hence GHG emissions may be increased

*They are listed in order of priority by farmers

Table 5. *Alternative feed sources*

	Supplementary dairy feed											
	Minerals		Pine apple waste		Brewer's waste		Poultry waste		Maize gem		Dairy meal	
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Githunguri	96%	4%	26%	74%	33%	67%	11%	89%	100%		100%	
Ruiru		100%	7%	93%	7%	93%		100%	87%	13%	100%	

Cost process of fodder

The gross margin and net income of Napier and maize are shown in table 6.

Table 6. *Comparison of gross margin and net income for Napier and Maize (in KES per acre)*

	Napier	**Maize**
Gross Output	50,400	94,200
Variable Costs	17,600	44.890
Gross margin	**32,800**	**49,310**
Depreciation and Interest	3,567	10,720
Net Income	**29,333**	**38,590**

Maize production is more profitable than Napier production, however, Napier is more nutritive than maize in terms of protein and fibre content (Table 6). Maize can be equally competitive in nutritive value if it is reinforced with legumes. 14% of the farmers highlighted that making Napier silage is a problem and it is associated with many losses. Hence it is best to use cut and carry system to avoid losses on a handful of Napier from the small piece of land. Napier is the farmer's favourite feed due to its many advantages. Hence, it has more advantages than maize production. However, intercropping maize with a legume crop is more profitable since it improves quality of feed and soil quality at the same time. Maize can be grown 3 times a year and provide the required amounts of feed and its suitable for silage. It is recommendable and advantageous to use maize as an alternative to Napier for climate smartness and feed security.

References

- Honour Shumba, 2018. Integrating Climate Smart Agriculture interventions in Small holder dairy feed value chain in Githunguri and Ruiru Sub-county, Kiambu county, Kenya. Thesis Master Agricultural Production Chain Management.
- Gachuiri C.K, Lukuyu M.N, & Ahuya C.A, 2012. Dairy Farmers Training Manual. Ministry of Livestock Development, Kenya Dairy Sector Competitiveness Programme, Nairobi, Kenya. GDFCS, 2018. Githunguri Dairy Farmers Cooperative Society Homepage, available from: https://www.fresha.co.ke/content.php?com=1 &item=1> Accessed on 30 May, 2018.
- Gereffi, G.; Humphrey, J; Sturgeon, T., 2005. The Governance of Global Value Chains. In: Review of International Political Economy, 12:78-104.
- Muriuki, H.G., 2011. Dairy development in Kenya. FAO, Rome.

Modelling GHG emission and cost and benefit analysis within the dairy farming system. A case study of Githunguri Dairy Farmers Cooperative Society Ltd and Olenguruone Dairy Farmers Cooperative Society Ltd, Kenya

Anastasia Vala, Marco Verschuur, Robert Baars, Robert Serem

Practice Brief
CSDEK Project 2020-04

CSDEK = Inclusive and climate smart business models in Ethiopian and Kenyan dairy value chains

Understanding the effects of GHG emissions and cost and benefit analysis within the dairy farming system has become an important concern with respect to food security.
In 2018, VHL students carried out research in Githunguri-Kiambu county with the aim of scale-up climate-smart practices in smallholder dairy farming in the context of the project Climate Smart Dairy in Ethiopia and Kenya (CSDEK) (Baars et al., 2019). The team conducted research in scaling up mitigation practices in small holder’s dairy value chain (Kiiza, 2018), integration of climate-smart agriculture practices in feed value chains (Shumba, 2018), and integration of climate-smart agriculture in supporters of Kiambu Dairy Value chain and knowledge support systems (Wangila, 2018). The key focus was to have interventions that reduce emissions intensity while maintaining or increasing milk production such that climate change and productivity can be tracked together. Although interventions for scaling up practices that support low emission in the dairy production systems have been identified and business models developed, the in-depth analysis of economic, environmental cost and benefit component is not inclusive in the developed business models.

Based on the CSDEK 2018 inventory, the main objective of this study was to evaluate the impact of climate-smart practices in the dairy farming systems centred on economic and environmental cost (GHG emission) and benefit analysis to advice about the enhancement of scalable dairy farming systems on the inclusive and resilient business model.
The study used both a qualitative and quantitative approach for data gathering and both primary and secondary data collection techniques. The study was conducted between 1 July 2019 to 15 August 2019 for farmers of Githunguri and Olenguruone dairy farmer's cooperative society in Kenya. Average farms were compared to farms with best practices. Purposive random sampling was done to identify 4 farmers in Githunguri and surroundings (Kiambu county) and 2 farmers in Olenguruone (Nakuru county). Four dairy farms used a zero-grazing system (intensive) and two a semi-intensive system. The intensive systems confined their animals fully, while those in semi-intensive kept them in the units at night and released the dairy cows to graze in paddocks during the day. Attributional LCA (life cycle analysis) was used to quantify the environmental impact upstream (feed transport and processing), and on farm (dairy herd, manure management and on-farm feed production).

Scalable climate smart dairy practices

Table 1. *climate smart practices within the dairy farming systems*

Smartness category	Indicators
Water smartness	Water harvesting tanks and storage tanks
Energy smartness	Use of biogas/ biodigesters, solar panels, water baths
Carbon smartness	Agroforestry, crop rotation
Nitrogen smartness	Use of manure, bio-slurry, compost, mulching, fodder legumes and trees
Weather smartness	Agroforestry, fodder production and conservation
Knowledge smartness	Attending farmers training, sharing dairy management knowledge with other farmers, adoption of knowledge in dairy production
Gender smartness	Equal opportunities in dairy production for women and youth e.g access to knowledge, loans

Source: Adopted by Kiiza (2018) from World bank and CIAT (2015).

Kiiza (2018) used the categories of smartness (Worldbank and CIAT, 2015) to indicate observed climate smart practices (Table 1). Table 2 shows the CSD practices observed by the case study farmers. Farmers ranked fodder conservation as a priority CSA practice that they would want to upscale among others simply because, they felt that fodder conservation was an adaptive capacity in the event of climate change (Table 3). One of the main pollution practices is the flow of manure along the roads (Figure 1).

Table 2. *Farmers' adoption of climate smart practices*

Climate smart practices	% of farms
Biogas/biodigesters	66%
Water harvesting structures/water tanks)	100%
Fodder conservation structures and technologies	100%
Application of slurry and manure in crop fields	100%
Milking machine	33%
Solar panels	33%
Water baths	33%
Agroforestry	83%

Results from the study showed that, biogas production can be climate smart by trapping CH_4 emissions per litre released by manure to the atmosphere. Apart from biogas being climate smart, farmers saved fuel costs by using it. It is therefore, not only a GHG mitigation practice, but also a cost reduction strategy. Water harvesting tanks saved the cost of pumping water from the well and solar panel implied reduction in electricity bills. Therefore, GHG emissions and productivity can be tracked together and the value proposition of climate-smart practices can be proved to the farmers.

Figure 1. *Manure flowing along the roads*

Although farmers ranked the CSA practices, enteric fermentation (CH_4) is the major source of emissions in the farm due to the type and the quality of feeds. Therefore, scaling feed production and the type of feed given to animals will be crucial in the reduction of CH_4 emissions. The type and quality of feed stuffs will determine milk production hence emissions kg CO_2 eq. per litre.

Table 3. *Ranking of scalable climate smart practices by farmers*

Climate Smart Dairy practice	**Order of ranking**
fodder conservation	1
breed upgrading	2
biogas/ bio digesters	3
water harvesting technology/ tanks	4
manure application in the fields	5
mechanization(milking machines)	6
intensive dairy farming (zero grazing)	7
solar energy/ solar panels	8
agroforestry	9
water baths	10

Feed and Feed quality

The land size for farmers in Githunguri was 1- 3 acres with an exceptional one that had 30 acres, while for Olenguruone it was 5 -12 acres. Farmers in Githunguri had small pieces of land compared to those in Olenguruone. Around the homestead, farmers had farm structures (zero-grazing units, fodder stores/feed stores), vegetable gardens and fodder production as well as agroforestry. Those with small land sizes produced fodder from rented lands near their farms. The farmers also bought fodder e.g. hay, concentrates e.g. dairy meal, wheat bran and wastes e.g. brewers' yeast, pineapple waste and poultry waste (Table 4), while some of them prepared their homemade rations (Table 5).

Table 1. *Available feedstuffs in the farms.*

Fodder	Fodder Trees
Napier Grass Nandi Setaria Kikuyu grass Kikuyu grass improved Brachiaria Boma Rhodes (hay) Oats Sorghum fodder Maize fodder Edible cana (dry season)	Lucerne tree Sesbania sesban Caliandra Grevillea Mulberry tree **Legumes** Desmodium Lucerne (Alfalfa) Lupin (sweet and bitter lupins)
Concentrates	Wastes
Dairy meal Wheat bran Maize germ	Pine apple waste Brewers' yeast Poultry waste

Table 2. *Homemade rations*

Dairy homemade ration (50 kg)
6 kg wheat bran 6 kg cotton seed cake 17.5 kg maize germ 12.5 kg maize grain flour 2.5 kg soy bean meal / cake 5 kg sunflower 0.25 kg limestone 0.33 kg salt (magadi)
Lupin and maize flour
1 kg lupin : 3 kg maize flour
Pineapple waste
15 kg Napier grass + 5 kg pineapple waste
Brewers' yeast
5 liters H_2O 3 kg brewers' waste 3 kg homemade ration
Poultry waste, maize germ and wheat bran
16 x 10 kg of poultry waste 19 x 50 kg bags of maize germ 14 x 50 kg bags of wheat bran

Wastes were highly used, since it was ample available in the neighbouring (sub)counties. Pineapple juice and by-products without the crown have a higher energy value than maize silage and are able to partly replace energy concentrates diets for ruminants. It is very palatable and used in total mixed rations for dairy cows (Figure 2). The nutritional value of pineapple in DM% is 88.6, CP 4.5 %, Gross energy MJ/Kg DM 17.0 and ME MJ/Kg DM 10.8 (Heuze, et al., 2015). Brewers' yeast was fed during milking as the farmers said it increased milk production. Brewers' yeast as a source of protein contains 50% DM and CP of 40 – 50 % (Heuze, et al., 2018).

Figure 2. *Pineapple waste preserved for dairy cows*

Milk production, livestock category, feed type and quality can vary enteric fermentation in a farm hence CH_4 emission. Therefore, farmers who increase the milk production and check the type and quality of feed fed to the animal reduce GHG emissions in the farm. The adoption of climate-smart feed practices is not only a GHG reduction strategy on the farm but also a cost-benefit item.

Environmental and Economic costs
GHG emissions

Results show that the average carbon food print for milk production was 3.26 kg CO_2 eq. per litre. The carbon foot prints when milk was allocated to other functions of dairy farming, using the allocations of Weiler et al., (2014), was 1.03, 2.55 and 0.88 kg CO_2 per litre respectively (Table 6).

Table 6. *Carbon foot prints allocation of milk*

	Unallocated	**Allocated**		
	BE/ unit of milk kg CO2 – eq / l milk	**BE/ unit of milk 1. food production**	**BE/ unit of milk 2. economic prod**	**BE/ unit of milk 3. livelihood**
Farmer 1	5.72	1.16	5.64	1.54
Farmer 2	2.87	1.17	0.60	0.77
Farmer 3	1.87	1.79	1.32	0.50
Farmer 4	1.30	1.04	0.04	0.35
Farmer 5	1.41	0.48	0.03	0.38
Farmer 6	0.42	0.15	0.02	0.11
Average	**3.26**	**1.03**	**2.55**	**0.88**

NB: BE refers to Baseline Emissions according to IPCC 2006

Economic parameters

Table 7. *Cost and Revenue Streams [in KES] within the dairy farming systems.*

Farmer	1	2	3	4	5	6	Average
Cooperative	**Githunguri**				**Olenguruone**		
Farming system	**Intensive**	**Intensive**	**Intensive**	**Semi Intensive**	**Intensive**	**Semi Intensive**	
Herd size	66	4	5	79	18	6	29.7
Milking cows	57	2	4	44	8	3	19.7
Average milk yield/cow	3584	1120	2388	4264	5475	5475	3932
Total milk yield /year (L)	204,316	2,240	9,553	187,610	43,800	16,425	77,324
Price / litre (KES)	38	38	38	40	30	30	35.7
Milk revenue (KES)	7,764,008	85,112	363,022	7,504,400	1,314,000	492,750	2,920,549
Other revenues	1,049,050	52,230	93,740	1,316,800	470,250	125,550	768,687
Total revenue (TR)	8,813,058	137,350	456,754	8,821,200	1,784,250	618,300	3,689,235
Fixed costs (FC)	210,559	7,305	13,077	662,675	400,267	12,319	217,700
Variable costs (VC)	2,696,640	185,220	297,400	5,809,800	1,407,763	214,800	1,768,604
Total costs (TC)	2,907,199	192,525	310,477	6,472,475	1,808,029	227,119	1,986,304
Gross Margin (TR-VC)	6,116,418	-47,870	159,354	3,011,400	376,488	403,500	1,669,882
Net Result (NR=GM-FC)	5,905,859	-55,175	146,277	2,348,725	-23,779	391,181	1,452,181
Net Result per litre milk	28.9	-24.6	15.3	12.5	-0.5	23.8	18.8
Cost price per litre milk	9.1	62.6	22.7	27.5	30.5	6.2	19.0

profit-cost ratio(NR/TC)	2.03	-0.29	0.47	0.36	-0.01	1.72	0.7
Total cost/cow/year (TC/milking cows)	51,003	96,262	77,619	147,102	226,004	75,706	112,283
Net Result /cow/year (NR/milking cows)	103,612	-27,587	36,569	53,380	-2,972	130,394	48,899
Estimated* savings on climate smart practices	288,000	12,000	-	138000	365,000	12,000	163,000
Savings* / cow with CSA	5,053	6,000	0	3,136	45,625	4,000	10,636
Net Result without CSA	5,617,859	-67,175	146,277	2,210,725	-388,779	379,181	1,316,348
Net Result/cow without CSA	98,559	-33,587	36,569	50,244	-48,597	126,394	38,263

*NB: The cost savings per year on climate-smart practices (biogas production, water harvesting and solar panels) are estimates from the farmers based on how they spent before the adoption of the practice.

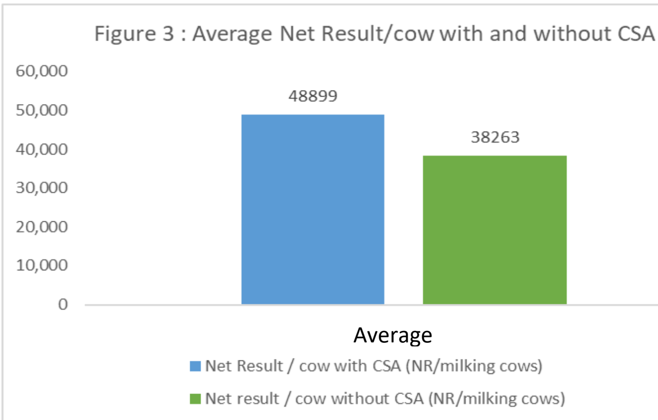
Table 8. *The carbon foot print of FPCM and dairy profit [Kg CO_2 eq/litre]*

	G1	G2	G3	G4	O1	O2	Average
Farming system (I=intensive; S-I=semi-intensive)	I	I	I	S-I	I	S-I	
Carbon footprint [Kg CO_2 eq/FPCM litre]	5.72	2.87	1.87	1.30	1.41	0.42	3.26
Profit /litre all products considered [KES]	28.9	-24.6	15.3	12.5	-0.5	23.8	18.8
Cost price / liter milk [KES}	9.1	62.6	22.7	27.5	30.5	6.2	19.0

Table 7 shows the economic parameters of the 6 farm cases. Herd sizes, production and economic data are quite different. Given the small number of cases, average production in Olenguruone seems to be higher than in Githunguri. All farms resulted to be profitable, except for Farm 2, due to the low average milk yield and for Farm 5, due to high cost price. 'Carbon footprint/litre, profit/litre and cost price/ litre milk' makes the cases comparable in (cost-benefit) efficiency (Table 8). In Githunguri, Farm 1 is a large farm with a very high carbon foot print and very low cost price, while farm 2 is a small scale farm with a high carbon foot print and high cost price. In Olenguruone, Farm 5 is a middle large farm, with a relative high cost price, while Farm 6 is a small farm with a very low cost price and low foot print. The cost-benefit analysis of the climate-smart practices biogas production, water harvesting and solar panel show that farmers with climate-smart practices had an average net result per cow with CSA of KES 48,899, while estimated without CSA KES 38,263 (Table 7; Figure 3).

Conclusions

- Farmers ranked fodder conservation as a priority the climate smart practice.
- Biogas/biodigesters reduced GHG emissions, while CH_4 saved fuel costs. Water harvesting technology and solar panels also saved costs.
- Enteric fermentation, CH_4, is the major source of emissions due to the type and the quality of feeds.
- Therefore, scaling feed production and the type of feed that is given to animals will be



crucial in the reduction of CH_4 emissions. The quality and type of the feed will determine milk production hence emissions Kg CO_2 eq. per litre.

Recommendations small scale farmers

- In order to reduce production costs, avoid wastages in feeds and especially concentrates by feeding the right quantities. Fodder production from own farm is important as it guarantees quality fodder because of proper management. However, those with small land sizes can form groups, where you can contract fodder producers to produce fodder for you and you, are guaranteed of quality.
- Manure management is key to GHG reduction but also as an income-generating enterprise. It is important to collect manure and store it to be sold to other farmers and to avoid the running of manure along the roads from the farm.
- Adoption of climate-smart practices, e.g. biogas, water harvesting, fodder production and conservation as they are beneficial in saving production costs in the farm.

Recommendation dairy cooperatives

- Creation of awareness on the CSA practices within the farming systems through Extension.
- Assist farmers in the implementation of CSA technologies through loans with affordable interests.
- Capacity building of farmers on the preparation of homemade rations for quality feed and save the cost of purchasing commercial concentrates and also the feeding management of dairy cows.
- Capacity building on hygiene and condition of the zero-grazing units for clean milk production.
- Train farmers in manure management especially covering of manure during storage to reduce GHG emissions.

References

- Baars, R., M. Verschuur, R. Eweg and J. de Vries, (eds.), 2019. Inclusive and climate smart business models in Ethiopian and Kenyan dairy value chains. Practice briefs CSDEK project. Van Hall Larenstein, Velp, The Netherlands.
- GDFCS, 2018. Githunguri Dairy Farmers Cooperative Society Homepage, available from: https://www.fresha.co.ke/content.php?com=1&item=1> Accessed on 30 May, 2019.
- Heuze, V., Tran , G. & Giger, R. S., 2015. Pineapple by-products. Feedipedia, a Programme by INRA, CIRAD, AFZ and FAO. http://www.feedipedia.org/node/676. *Feedipedia. Animal Resource information System INRA.CIRAD, AFZ,FAO @2012- 2019*, 30 September, p. 69.
- Heuze, V. et al., 2018. Brewers Yeast. *Feedepedia Programme by INRA, CIRAD, AFZ, FAO. ttp://www/feedepedia/node/72*, 13 December, p. 72.
- Kiiza, A., 2018. Scaling Up Climate Change Mitigation Practices in Smallholder Dairy Value Chains: A case study of Githunguri Dairy Farmer Cooperative Society Ltd, Kiambu County, Kenya. Master thesis, VHL-Velp, The Netherlands.
- Serem, R., 2019. Scalability of climate-smart practice in forage supply chains. Case study of Githunguri and Olenguruone dairy societies in Kiambu and Nakuru Counties-Kenya. Master thesis, VHL-Velp, The Netherlands.
- Shumba, H.S., 2018. Integrating Climate Smart Agriculture interventions in small-holder dairy feed value chain in Githunguri and Ruiru sub-counties, Kiambu county, Kenya. Master thesis, VHL-Velp, The Netherlands.
- Vala, A., 2019. Modelling GHG Emission, Cost and Benefit Analysis within the Dairy Farming System. A case study of Githunguri Dairy Farmers Cooperative Society Ltd and Olenguruone Dairy Farmers Cooperative Society Ltd, Kenya. Master thesis, VHL-Velp, The Netherlands.
- Wangila, C. N., 2018. Integration of Climate Smart Agriculture in Supporters in Kiambu Dairy Value Chain and In Knowledge Support systems, Velp: VHL: Masters Thesis.
- Weiler, V., Udo, H.M.J., Viets, T.C., Crane, T.A., de Boer, I.J.M., 2014. Handling multi-functionality of livestock in a life cycle assessment: the case of smallholder dairying in Kenya. Current Opinion in: Environmental Sustainability: 8, 29–38.

Scalable climate smart dairy practices in forage supply chains. Case study of Githunguri and Olenguruone dairy societies in Kiambu and Nakuru counties, Kenya

Robert Serem, Marco Verschuur, Rik Eweg, Robert Baars, Anastasia Vala

Practice Brief
CSDEK Project 2020-05

CSDEK = Inclusive and climate smart business models in Ethiopian and Kenyan dairy value chains

van hall larenstein
university of applied sciences

The Climate-Smart Dairy in Ethiopia and Kenya (CSDEK) project carried out research in Githunguri-Kiambu county in 2018 with the aim of scale-up climate-smart practices in smallholder dairy farming (Baars et al., 2019). Both Kiiza (2018) and Shumba (2018) reported that scaling up climate-smart dairy practices is a challenge due to small land sizes and the majority of farmers are sourcing their animal feeds from other regions. Due to the high costs of production in the dairy sector and low supply of forage, farmers tend to buy any available and cheap feeds. These might be of poor quality thus leading to high GHG emission and low production in dairy farming. In addition, they also reported that the Rhode grass hay is the major forage used in the area though they outsourced from other regions, besides the Napier grass, which are available in the area. Farmers acquire this kind of forages from local stockist (Agro-vets), Dairy Cooperative stores and some buy from the other farmers. According to Shumba (2018), Githunguri DFCS plays a crucial role in the forage value chain by acquiring mainly Rhode grass hay and selling it to their dairy farmers through a check-off system against milk. However, not all farmers buy from their cooperative outlets but also from other private stockist or from roadside traders. The aim of this research was to carry out an in-depth analysis into the forage value chain, identifying forage chain actors, supporters and estimate costs of production, GHG emissions and energy consumption at production level and along the chain, with the objective of developing business model for scaling up climate-smart dairy farming practices in Githunguri Dairy Farmers Cooperatives.
The study used both a qualitative and quantitative approach for data gathering and both primary and secondary data collection techniques. The case study was carried out between 1 July 2019 to 30 August 2019 in different farms in four different counties: Githunguri- Kiambu county, Narok East and South, Nakuru and Ruaraka-Nairobi county. This was achieved through snowball sampling techniques.

Forage supply chain in the Githunguri and Olenguruone dairies

The forage value chain varies depending on the type of forage. In Githunguri, Napier and roadsides grasses are grown in and around the farm (short chain), while by-products of pineapple and breweries are bought directly from the factory (medium chain) and Rhodes grass hay and wheat and rice straws are purchased via local retail (long chain) (figure 1). Based on the study, Napier grass and other green forages had the shortest chain. This was

observed in Githunguri and Olenguruone (figure 1 and 2). Farmers were buying or leasing from their neighbouring farmers or getting forage from the road side sellers. This was also in line with by Auma et al. (2018) (USAID-KCDMS assessment report). The long value chain was observed in Githunguri Dairy Farmer Cooperative Society (GDFCS), where the cooperative takes the responsibility of buying forage on behalf of its members.
The short value chain was more practiced in Olenguruone than in Githunguri area.

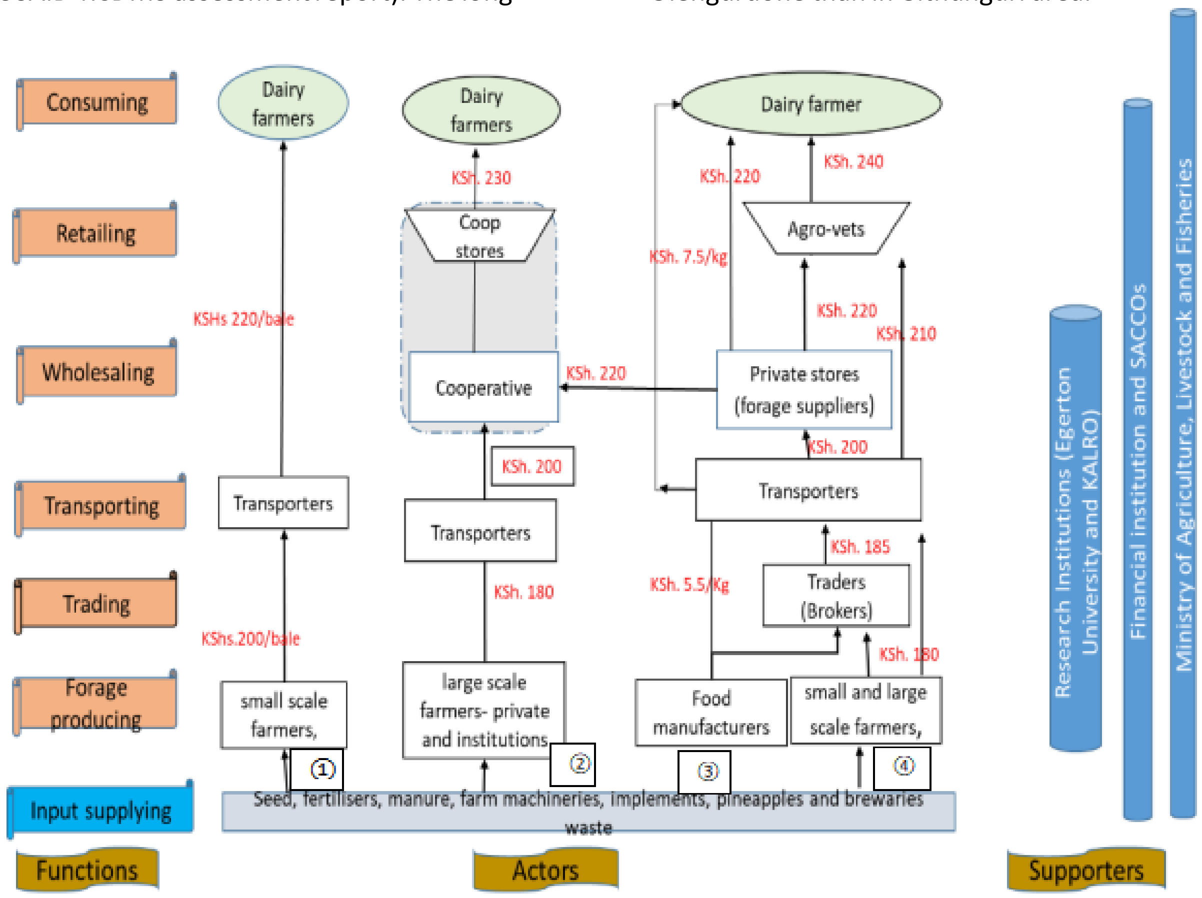


***Figure 1.** Githunguri DFCS Forage value chain map*

Forage chain governance

In Githunguri cooperative store department (procurement office) purchases Rhodes grass hay from a few identified large scale farmers (hay producers). This study discovered that no binding agreement is made or no procurement procedures are followed, but they buy according to the market price depending on their negotiation power. Besides, upcoming forage producers are coming to seek for market in cooperative. To ensure the quality, the quality of hay will be checked before the price agreement. The research identified only the market type of forage chain governance in Githunguri DFCS. As explained by Gereffi et al., (2005) there is no formalization in cooperation between the hay producer and the cooperative and the cooperative to a dairy farmer, the cost of switching to a new partner is low for both, it depends on the willingness of the buyer and that of the seller. It was found that the cooperative had no control interest in the hay production; they were only giving the kind of quality standards they require. However, most dairy farmers were not sure or aware where the cooperative sources the Rhode grass hay this has caused mistrust from other members forcing them to shift the sourcing.

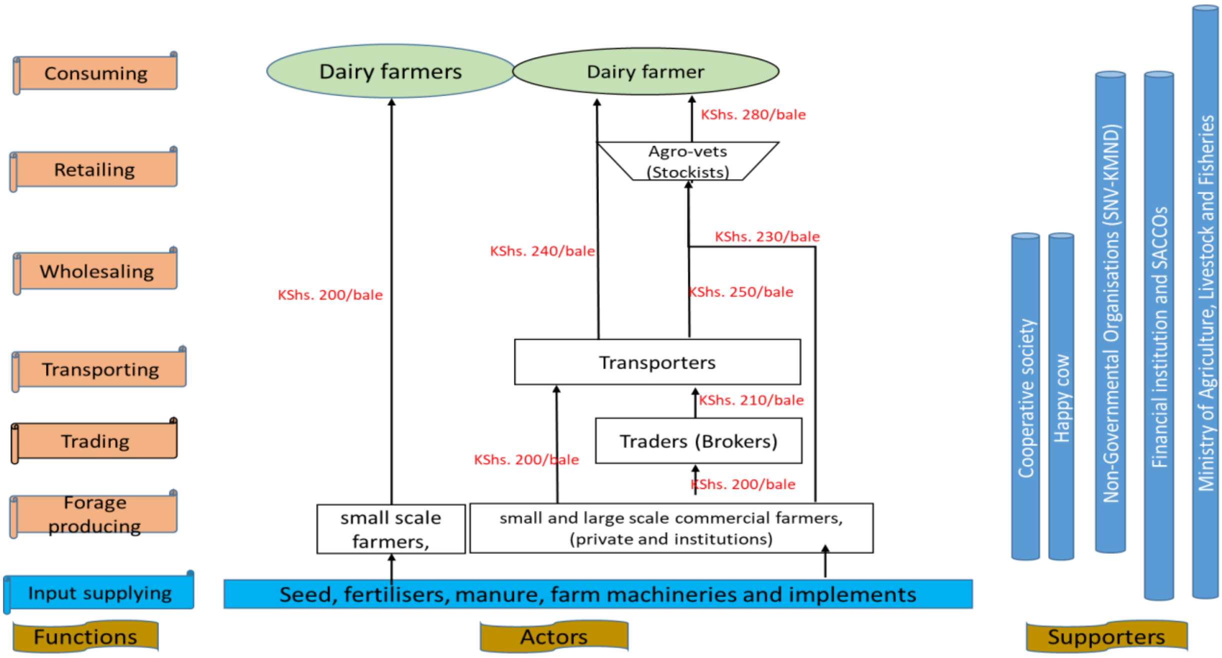


Figure 2. *Olenguruone Forage value chain map*

Storage and preservation techniques

The study identified that most large scale producers do not have storage facilities, they bulked them in the field and cover with the polythene paper as in figure 3 No. 3 and figure 4. Others have old stores with a leaking roof (No.1) and not well covered. Some have well-structured stores (No.2). These practices contribute to poor quality hay leading to high GHG-emissions.

Figure 3. *Types of storage facilities and techniques*

Cost of Rhodes hay production

Majority of small scale farmers are producing Rhodes grass for subsistence and sometimes sell excess during the dry season. Medium and large-scale farmers are growing for commercial purposes. High-interest rates from financial institutions, taxes for farm inputs especially machinery, inflation and lack of access to credit facilities have contributed to the high cost of production.

Figure 4. *Covered Rhodes grass hay*

Forage (Rhode grass hay) producers were categorised based on the capital resources specifically machinery. However, the study found that small- and medium-scale hay producers were contracting machinery service during hay harvesting and transporting. This is due to the high cost of farm machinery and limited access to finance. Table 1 shows the production cost comparison of two medium farms from different counties with and without machineries. The farm without farm machinery, such as Ngongongeri farm in

Nakuru, shows that there is a low gross margin (2.15%) per hectare at the initial stage of Rhodes grass production. This was caused by the high cost of establishment of Rhodes grass. The same farm recorded 52.1% gross margin per hectare in the second season of harvesting. However, on the farm with machinery such as Kenfine in Kiambu county recorded higher than the medium farm with 19% gross margin per hectare but closely the same for the second season.

Table 3. *The cost of Rhodes grass hay production*

	FARM 1 -Kenfine farm (OWN MACHINERIES)		*FARM 2 -Ngongongeri farm (CONTRACTED SERVICE)*	
ACTIVITIES	*Cost of production crop establishment/ ha (KSHs)*	*Cost of production (established crops)/ha (KSHs)*	*Cost of production establishing crop/ ha (KSHs)*	*Cost of production established /ha*
Ploughing	1815.45	0	8645	0
1st Harrowing	2074.8	0	3705	0
Raking	1296.75	0	2470	0
Labour	15808	8645	17290	10374
2nd Harrowing	2074.8	0	3705	0
Planting	1296.75	0	2470	0
Fertiliser(250kg/Ha)	14820	7410	14820	7410
Seeds (10kg/Ha)	9880	0	9880	0
Compaction	1556.1	0	2470	0
Weeding	1037.4	8645	8645	8645
Harvesting	6743.1	37050	29640	37050
Total Variable Cost	83,103.15	61750	103,740	63479
Yield per hectare	494	617.5	494	617.5
Average/kshs/bale	220	220	220	220
Total revenues	108,680	135,850	108,680	135,850
Gross margin	**19.7%**	**52.3%**	**2.15%**	**52.1%**
*Fixed cost**	4,155.20	3,087.5	2593.5	1,587
Net profit/ha	21,421.65	71,012.5	2,346.5	70,784

Demand and supply of forage

The study discovered that, dairy farmers in both areas do not buy forage (Rhode grass hay) during the rainy season. However, the demand of hay bales is high during dry seasons and the supply at that period is low as shown in figure 5, forcing the prices to elevate gradually. During the wet seasons, there are plenty hay bales, the prices are low and quality is likely to be high.

Quality and prices of hay

Farmers do not buy forage based on quality, but quantity. In most cases, prices are determined by demand. The higher the demand the higher the prices. The findings show that during harvesting periods, price is low per hay bale and quality is high, but the demand is low since the dairy farmer has enough forage at that period.

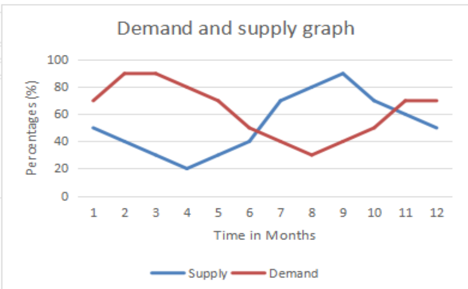


Figure 5. *demand and supply of Rhodes hay*

Greenhouse Gas emissions (GHG)

The demand for forage has increased the prices per bale and the cost of transportation is also very high, making it difficult for dairy farmers to buy in bulk enough for all year. Lack of storage facilities at dairy farms is one of the factors contributing to high emission along the chain, as dairy farmers tend to make several trips for the same products. Using the data from Githunguri cooperative dairy society (total Rhode grass bales recorded was 27,199 bales as from July 2018 to June 2019).

It shows that, transporting Rhode grass from kenfine farm in kiambu by using an old truck with capacity of 500 bales and consuming diesel fuel at the rate of 3 kilometre per litre, the emission was **10.68 $KgCO_2$** eq.in a round trip (that's from destination to farm and back thus giving 11 X2 =22km), while using small truck with capacity of 200 bales to carry same number of bale (500bales) and fuel consumption of 6 Kilometre per litre, the emission was **14.685 $KgCO_2$ eq**. But using modern large truck with capacity 500 bales from the same farm (one trip) the total emission reduced to **4.895 $KgCO_2$ eq.**

On the other hand, transporting Rhode grass from Ngongongeri farm in Nakuru (round trip) to Githunguri Dairy Cooperative Society, the old truck with capacity of 500 bales but high consumption of fuel (3km/lt) produced total emission was 302.6$KgCO_2$ eq. Smaller truck with capacity of 200bale carrying same number of bales, that is 500 bale will go for three trips therefore producing total emission of 453.9$KgCO_2$ eq but modern truck with capacity of 500 bale and efficient in fuel consumption of 6km per litre will produce less emission of 151.3$KgCO_2$ as shown in table 2.

Scalable climate smart forage chain practices

The study has identified several scalable climate-smart practices in forage supply chain:
Chain governance: Improvement of forage value chain governance that ensures dairy farmers get enough and quality forage and reduce seasonal fluctuations.
Means of transportation: use of large hay trucks that can transport many hay bales at once.

Table 2. Emission along the chain by using old truck, small trucks modern large truck

Energy and CO2eq along the Chain (Production to Consumption)

SOURCE OF FORAGE	*Type of forage*	*distance (km) (round trip)*	Truck carrying 500 bale per trip at fuel consumption rate 3km per litre						Truck carrying 200 bales/trip at fuel consumption rate of 6 Km per litre(500 bales equivalent)						Truck carrying 500 bales/trip at fuel consumption rate of 6 Km per litre					
			Diesel in litres	*cost of fuel*	*energy consumed/ trip(Mj)*	*KgCO2eq emission*	*Energy MJ/bale*	*KgCO2eq/bale*	*Diesel in litre*	*cost of fuel*	*energy consumed≈500 bales*	*KgCO2e emission/total trips*	*Energy consumed MJ/bale*	*GHG emission KgCO2eq/*	*Diesel in litre*	*cost of fuel*	*energy consumed≈500 bales*	*KgCO2e emission/total trips*	*Energy consumed MJ/bale*	*GHG emission KgCO2eq/ bale*
Kenfine farm Kiambu	Rhode grass	11	4	420	143.6	10.68	0.2872	0.02136	5.5	577.5	197.45	14.685	0.3949	0.0294	1.83	192.5	65.82	4.895	0.1316	0.0098
Ngongongeri farm Njoro	Rhode grass	340	113	11900	4068.7	302.6	8.137	0.6052	170	17850	6103	453.9	12.206	0.9078	56.7	0.54	2034.33	151.3	4.0687	0.3026

Energy (Fuel combustion and transportation): Energy is very important in every stage of food production, transport being part of it. Using improved means of transport in terms of size and efficiency will reduce energy loss, at the same time GHG emission. Most farmers and transporters were using small sizes and old trucks as shown in figure 6.

Figure 6. *Mean of hay transport*

Post-harvest losses: lack of storage facilities have contributed to low adoption of climate-smart practices. Covering hay in the field as shown in figure 4 is exposing to high risks such as bad weather and a high percentage of waste, which might forage causing scarcity at the end. Lack of storage facilities at dairy farm level also contributes to the high loss of forage as the farmer is forced to feed the animal more than the required.

Recommendations

To address these challenges, the researcher suggests that the construction of large storage facilities and conservation centre in main designated area (e.g. cooperative outlets) and also at dairy farmers level. This will reduce GHG emissions, transport costs as well as price fluctuations, thus reducing the cost of production per unit litre of milk, therefore, improving the livelihood of Dairy farmer in Githunguri area.

References

- Auma, J.O., Omondi, I.A., Mugwe, J.G., Rao, E.J.O., Lukuyu, B.A. and Baltenweck, I., 2018. USAID-Kenya Crops and Dairy Market Systems (KCDMS): Feed and fodder value chain assessment report.
- Baars, R., M. Verschuur, R. Eweg and J. de Vries, (eds.), 2019. Inclusive and climate smart business models in Ethiopian and Kenyan dairy value chains. Practice briefs CSDEK project. Van Hall Larenstein, Velp, The Netherlands.
- GDFCS, 2018. Githunguri Dairy Farmers Cooperative Society Homepage, available from: https://www.fresha.co.ke/content.php?com=1&item=1> Accessed on 30 May, 2019.
- Gereffi, G., Humphrey, J. and Sturgeon, T., 2005. The governance of global value chains. *Review of international political economy*, *12*(1), pp.78-104.
- Kiiza, A., 2018. Scaling Up Climate Change Mitigation Practices in Smallholder Dairy Value Chains: A case study of Githunguri Dairy Farmer Cooperative Society Ltd, Kiambu County, Kenya. Master thesis, VHL-Velp, The Netherlands.
- Serem, R., 2019. Scalability of climate-smart practice in forage supply chains. Case study of Githunguri and Olenguruone dairy societies in Kiambu and Nakuru Counties-Kenya. Master thesis, VHL-Velp, The Netherlands.
- Shumba, H.S., 2018. Integrating Climate Smart Agriculture interventions in small-holder dairy feed value chain in Githunguri and Ruiru sub-counties, Kiambu county, Kenya. Master thesis, VHL-Velp, The Netherlands.

Inclusiveness and resilience for scaling up climate smart dairy farming. A case of Githunguri and Olenguruone dairy farmers, Kenya

Florence Aguda, Robert Baars, Leonoor Akkermans

Practice Brief
CSDEK Project 2020-06

CSDEK = Inclusive and climate smart business models in Ethiopian and Kenyan dairy value chains

The Kenyan dairy industry is characterised by rapidly expanding formal milk markets with a high participation of smallholder farmers. Dairy farming is a large contributor to Green House Gas emissions and is itself quite vulnerable to direct and indirect impacts of climate change. Climate smart dairy is key to development through adoption and utilization of efficient production resources, increased productivity, good health and reduced impact on the environment.

Bernier et al. (2015) indicated that climate smart agricultural strategies may not be effective or transformative without the inclusion of women and youth. There is an increase in adoption of climate smart practices when women's knowledge, awareness and access to agricultural information and practices increase. Both male and female livestock farmers are key in the implementation of smart dairy actions (Wambugu et al, 2011).

The aim of this study was to analyse the male and female dairy farmers' awareness, knowledge, and skills on climate smart agriculture as regards to inclusiveness and resilience.

This study was conducted in two areas: Githunguri in Kiambu County and Olenguruone in Nakuru County among small-scale dairy farmers. The majority of the dairy farmers in Githunguri practice intensive dairy production, whereas in Olenguruone farmers practice both intensive and semi-intensive dairy production.

Picture 1. *Focus group discussion.*

The study used a qualitative approach. Twelve male and 12 female smallholder dairy farmers as well as eight key informants were individually interviewed in both Githunguri and Olenguruone areas. In both study areas three focus group discussions were conducted (Picture 1).

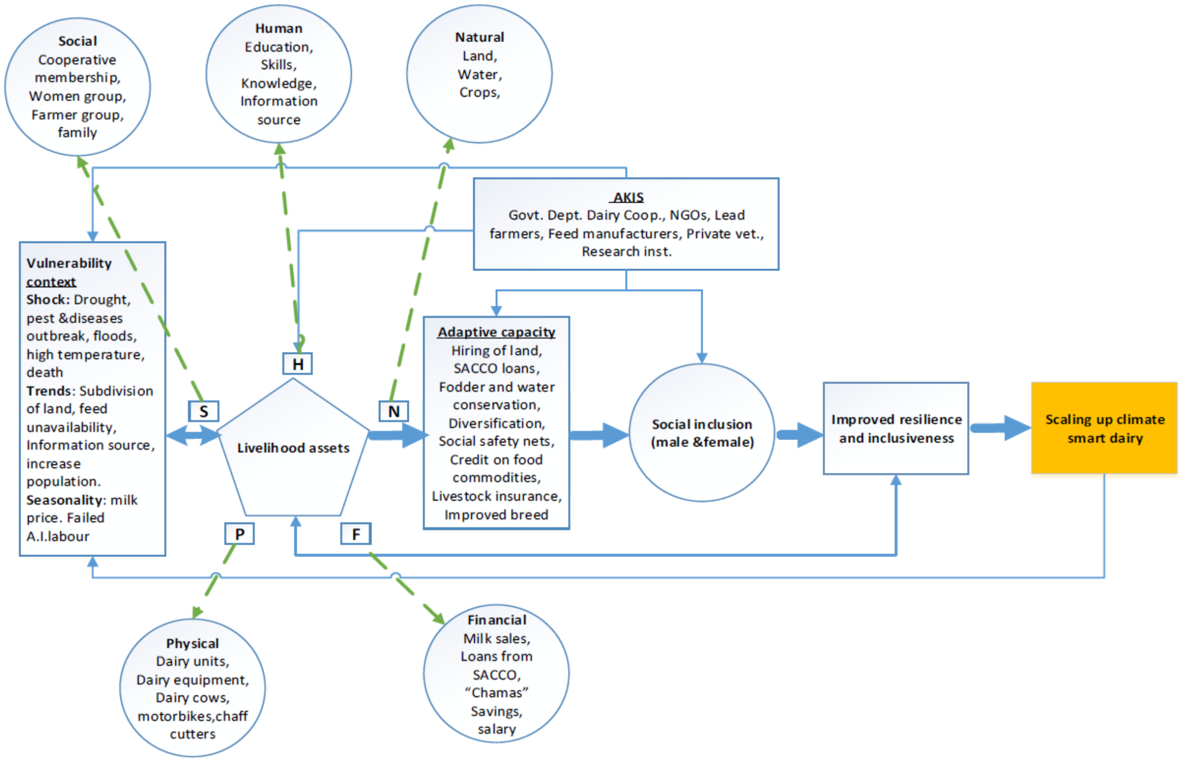


Figure 1. *Conceptual framework of the study*

The conceptual framework of the study was a combination of the Sustainable Livelihood Framework (DFID, 1999), Resilience Framework (Bene et al, 2012) and Social Inclusion Framework (Figure 1).

Vulnerability

Climate change is affecting small-scale dairy farmers in Olenguruone and Githunguri in both direct and indirect ways. The direct effects drought, floods, death and diseases were similar to men and women (Figure 2). Indirect effects were seasonality, shortage of labour, increased population growth, increased input prices and changes in milk price. Though the cooperative is providing a ready market to farmers', it is also a source of vulnerability as milk prices fluctuate. The cooperative does not offer competitive prices to cover the farmer's production costs.

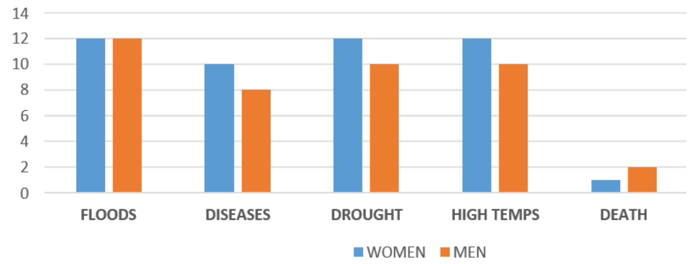


Figure 2. *Shocks to dairy farming*

Livelihood assets

Social capital of the dairy farmers consist of their fellow farmers, family members, churches and other social groups. The dairy cooperative is a strong social capital, especially for men who are registered members. Women equally scored high on the social capital through relationships with other farmers as they spend more time in the farms (Figure 3). Social capital is seen as an opportunity for scaling up climate smart dairy, especially for women.

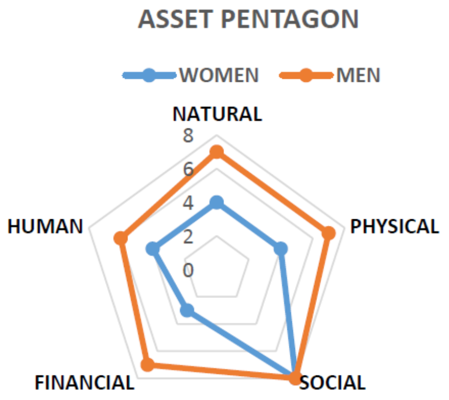


Figure 3. *Livelihood assets pentagon for men and women. Legend: 0-3 very low; 4-6: low; 7-8 average; above 8 very high.*

Financial capital enables dairy farmers to buy feeds and to access other dairy related services. The farmer's main source of financial capital was milk sales, employment and other income generating activities. Women scored low on financial capital as they have limited access to credit services.

Human capital is mainly determined by formal education, important to interpret and implement dairy information effectively. In this study, both men and women had formal education although a small number of women attained secondary education and above. Women with low education also had limited access to dairy information.

The main natural asset was land. Women's ownership of land is inhibited by cultural and customary land laws. This limits their choice of adaptive strategies as they encounter resource constrains and have limited access to information and services. Men on the other hand had diverse options mainly because of access to land, finance and information services. Men have control of all the important physical assets that are necessary for dairy production, including cows and dairy equipment, which consequently contributed to the lower score of women on physical resources. However, women have access to these physical assets though cannot make any decision concerning the purchase and disposal.

Gender in dairy farming

Women had access over the dairy assets land, cattle and even dairy equipment but they were excluded in the control, ownership and decision making (Table 1). During the focus group discussions this was attributed to culture and traditions. One focus group discussion in Olenguruone indicated that cattle ownership is considered a status symbol for men. It is used for payment of dowry and therefore cannot owned by women.

The cooperative extension officer also indicated that during advisory visits women are found in the farms although they do not make any decisions on the advice they give. Women have access to resources that do not have financial decisions attached to them. During a focus group discussion with men it was clear that culture has a role in what activities women and men do. Men considered women from their reproductive activities and felt that due to their reproductive roles, women do not make good dairy employees.

The focus group with the female dairy farmers, unanimously felt that the extension staff do not pay attention to them during advisory services because they do not make decisions on the advice offered to them.

Table 1. *Access (A) versus access and control (A/C) among Githunguri and Olenguruone male and female dairy farmers.*

Asset/Resource	Women	Men	Remark
Land	A	A/C	Men and women both have access to land but it is the men having control. Women with control have either purchased or inherited through widowhood.
Dairy animals	A	A/C	Source of prestige for men so women have no control over purchase or even disposal.
Sales	A	A/C	Women deliver the milk to the dairy but have no control over the sales. It is the prerogative of men.
Labor	A	A/C	Men mostly decide the level of labor to be used.
Extension/ trainings	A	A/C	Men mostly attend trainings although it is open to registered members who are mostly men.
Coop loans	A/C	A/C	Men control, as they are mostly registered Coop members and have collateral. The dairy Coop gives equal opportunities to all.
Dairy equipment	A	A/C	Men control what is to be used in dairy.
Water	A/C	A/C	Both men and women have access to water both for dairy and home consumption.
Zero grazing	A	A/C	Men control the type and size of structure to build.
Income	A	A/C	Cultural norms give men power to make decisions over allocation and use finances for an enterprise.

Picture 2. *A woman working on manure in a bio-digester.*

Adaptive capacity and resilience

To build resilience, dairy farmers implement strategies such as leasing of land, alternative feeding options, feed conservation, water harvesting, loans for food and feed, diversification and seeking employment (Table 2). Farmers engage in silage making after the rainy season when there is a lot of grass and forage, as an adaptive strategy that can be scaled up. However most farmers, especially women, considered it hard work. Most strategies are climate smart dairy practices although farmers were not aware.
The dairy cooperatives have both animal feed and human food loaning/credit schemes. However, this facility was mostly available for men who are members of the cooperative.

Table 2. *Adaptive strategies (practices) of female and male dairy farmers.*

Adaptive strategy	Women (N=12)	Men (N=12)	Men and women (N=24)
Leasing of farms	9	6	15
Loans from Sacco	4	9	13
Fodder preservation	3	6	9
Water harvesting	3	6	9
Improved breeds/animal health	3	6	9
Diversification	3	6	9
Innovativeness	3	4	7
Check off food commodities	6	0	6
Employment	0	6	6
Safety nets	1	3	4
Selling cows	0	4	4
Livestock insurance	0	3	3

More women than men were hiring or leasing farms for fodder production (Table 2), which was attributed to small land parcels and women not owning land because of cultural laws on land ownership. A female respondent said: "*… My brothers have only allowed me. They have not yet allocated me any portion as I am not married".*
When asked to rank climate smart technologies which they considered scalable, all women and male respondents (24) indicated feed conservation as the most important scalable climate smart technology (Table 3). Results further show that women preferred biogas and mechanization technologies more than men.

Table 3. *Scalable dairy smart technologies according to farmers.*

Technology	Ranking	Women	Men
Fodder conservation	1	12	12
Upgrading breeds	2	9	8
Biogas/Bio digester	3	12	4
Water harvesting technology	4	8	7
Mechanization: milking machines	5	8	6
Zero grazing	6	7	5
Solar panels	7	4	4
Agroforestry	8	4	3
Water Bath	9	2	4

Picture 3. Bio-digester in Githunguri.

Inclusiveness in dairy farming

Though female farmers were engaged in daily milking, feeding, watering, they were inhibited in advisory services and making decisions related to dairy production. Women and men occupy different social positions that influence their capacities to uptake new knowledge, technologies and affect change.
The Government of Kenya's policy on gender states that at least 30 per cent in all establishments is female. The dairy cooperatives employed many female employees, however, mainly in supportive hands-on work and not in decision making. The dairy cooperative has no gender policy in place. The implementation of government inclusion strategies continues to be slow due to the influence of the patriarchal society.

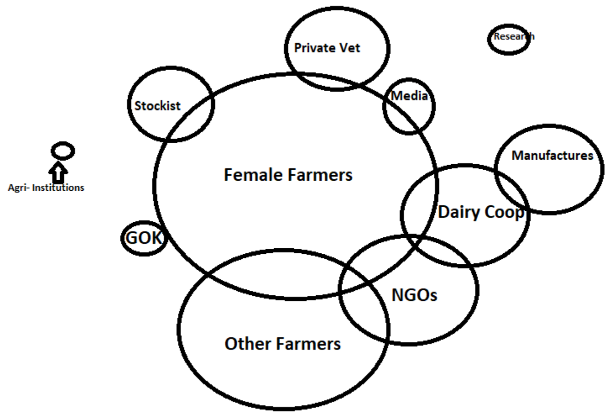


Figure 4. *Venn diagram from perspective of female dairy farmers. Size of circle indicates importance for female farmers, distance represents accessibility.*

Agricultural knowledge and information systems (AKIS)

The study identified extension linkages, market linkages and service linkages as information sources. There was no clear linkage between the different information sources. Access to training and extension is important to scale up climate smart dairy practices. The information sources and contacts of farmers influence the type of information farmer's access. Dairy farmers had both formal and informal sources of information. The information sharing strategies were field days, farmer field schools, farm visits, lead farmer approach and exchange visits. Both men and women preferred demonstrations and farmers training.
Women and men access dairy information differently. Practical farmers' schools and other farmers are an opportunity in scaling-up climate smart dairy among women. Women's main sources of production information were: farmers, relatives, NGO's, veterinary doctors and the local radio stations. The dairy cooperatives restricted its information services to their registered member's and most women were not members. Women tend to perform more duties and have less time to participate in the scheduled trainings. Men received trainings organised by dairy extension workers and farmer groups.
NGO's like SNV include women in their training policy. Their extension services are open to all as long as you are a dairy farmer, which increased the access of information by women. The State Department of Livestock states in its project policy that in every implementable project there has to be a component for women and other vulnerable groups. The dairy cooperatives have employed more women in service related jobs and in dairy extension service increase participation of women. Furthermore, the study established that time and location for trainings affected women's participation, as women dairy farmers have other household responsibilities. Further, the study noted that the provision of lunch and travel allowance as incentive to the dairy farmers influenced women more than men to attend the trainings.

Conclusions

- Livelihood strategies greatly differed among farmers, even within the same geographical location. Adaptive strategies were hiring of land for fodder production, water harvesting, feed conservation and diversification.
- Women and men have different access and control over the livelihood assets. Men own and control land, cattle and dairy equipment. Women do no control but have access to the same. Women have limited financial capital with limited access to credit services. Culture and social norms create differences resulting in reduced inclusion of women.
- Women play a significant role in dairy farming as they are involved in the management and husbandry of livestock even if they do not own them.
- Both men and women are involved in social networks in the form of family and friends.
- The dairy cooperatives promote the resilience of the dairy farmers in Olenguruone and Githunguri through credit facilities for feeds and food stuffs. They also provide a reliable and sustainable market for the farmers.
- The dairy cooperative extension services and trainings do not reach non-members, affecting women, although women registered at the cooperative were also incorporated in trainings.
- Women in male-headed households accessed dairy production information from

informal sources such as neighbours, family and other dairy farmers.
- Lead farmer approach and farmer schools were the most popular strategies of information sharing.
- NGO's include women in their programmes. The participation of women in Githunguri and Olenguruone areas was low attributed to low and slow returns in dairy production.

Recommendations

- Collaboration between research institutions, extension workers and dairy cooperatives so that they can come up with sensitization programmes that empower both women and men in climate smart dairy programs.
- Partnerships between dairy value chain stakeholders with the dairy cooperatives for capacity building of the dairy extension workers on dairy smart practices.
- Strengthening dairy farmers who are not enrolled in any cooperative through trainings and extension in both Githunguri and Olenguruone areas.
- Access to credit from the cooperative is restricted to members only. NGO's should help non-members to create linkages with other credit financing institutions.

References

- Bene C., Wood R. G., Newsham A. and Davies M. 2012. Resilience: New utopia or new tyranny? Reflection about the potentials and limits of the concept of resilience in relation to vulnerability reduction programmes. IDS (Institute of Development Studies) Working Papers 2012: 1-61.
- Bernier Q., Meinzen-Dick R., Kristjanson P., Haglund E., Kovarik C., Bryan E., Ringler C. and Silvestri S. 2015. What influences awareness and adoption of climate smart agricultural practices? Evidence from Kenya. [PDF] Available at: <https://cgspace.cgiar.org/bitstream/handle/10568/65680/Gender%20and%20Institutions%20Working%20Paper%2079.pdf > [Accessed 30 May 2018].
- DFID. 1999. Sustainable livelihoods guidance sheets. Department for International Development, London, UK. guides/livelihoods. [Accessed 28 February 2019].
- Wambugu S., Kirimi L., and Opiyo J. 2011. Productivity trends and performance of dairy farming in Kenya. Tegemeo working paper no 43. Tegemeo Institute of Agricultural Development and policy, Egerton University.

Financial constructions for dairy farmers adopting climate smart agriculture in the case of Githunguri and Olenguruone Dairy Farmers Cooperative Societies in Kenya

Wout van der Sanden, Marco Verschuur

Practice Brief
CSDEK Project 2020-07

CSDEK = Inclusive and climate smart business models in Ethiopian and Kenyan dairy value chains

van hall larenstein
university of applied sciences

Introduction

Van Hall Larenstein University of Applied Sciences (VHL) supports the adoption of Climate Smart Agriculture (CSA) among dairy farmers that are members of Githunguri Dairy Farmers Cooperative Society (GDFCS) and Olenguruone Dairy Farmers Cooperative Society (ODFCS) in Kenya. So far, studies of master students identified CSA practices and techniques to develop inclusive and climate smart business models (Baars, et al., 2019). However, not all CSA practices and techniques had similar adoption rates due to limited awareness and high expenses related to the adoption of CSA (Kiiza, 2018). To tackle these issues, this study aimed to comprehend the best financial practices of dairy farmers and the role of financial institutions in Githunguri and Olenguruone, regarding the adoption of biodigesters, rainwater harvesting, milking bucket machines and maize silage. The sample group consisted of 41 dairy farmers, 12 financial institutions, 4 CSA suppliers and staff members of both dairy cooperatives that were chosen by purposive sampling and snowball sampling.

Dairy Farmers and CSA

Dairy farmers invested in biodigesters, rainwater harvesting, milking bucket machines and maize silage to decrease expenses, increase productivity, become resilient to climate change and improve their quality of life (Figure 1). Rainwater harvesting was most accessible to dairy farmers, followed by maize silage, biodigesters and milking bucket machines. Dairy farmers utilised a wide range of financial practices to invest in CSA (Figure 1), though the most popular were using dairy proceeds, other agricultural related incomes and non-farming sources of income.

CSA Practice/Technique	Identified Reasons and Benefits	Identified Financial Practices
Biodigester	▪ Decrease expenses ▪ Convenient and better life ▪ Improved Health ▪ Environmental benefits	▪ Credit Products from SACCOs ▪ Savings of milk proceeds and other sources of income ▪ Salaries of other sources without savings ▪ Informal groups ▪ Leasing contracts ▪ Gifts
Rainwater Harvesting	▪ Decrease expenses ▪ Reliable access to clean and quality water ▪ Mitigation and resilience	▪ Savings from milk proceeds and other sources of income ▪ Credit from SACCOs ▪ Gifts ▪ Informal groups
Milking Bucket Machine	▪ Time-efficiency ▪ Decrease Expenses ▪ Improved hygiene ▪ Consistent milking method ▪ Improved milk quality	▪ Credit Products
Maize Silage	▪ Mitigation and resilience ▪ Convenience ▪ Improved fodder quality ▪ Improved milk quality	▪ Non-farming sources of income ▪ Dairy proceeds and other agricultural activities ▪ Credit ▪ Financial planning

Figure 1. *Reasons/Benefits to adopt CSA and best financial practices in Githunguri and Olenguruone*

Dairy farmers became clients/members of financial institutions to utilise payment and transaction services, access to savings and credit products and the option to purchase shares. The most important financial institution for members of GDFCS and ODFCS were GDC SACCO and Mavumo Daima SACCO respectively, both subsidiaries of the dairy cooperatives. In addition to formal access to finance, dairy farmers had access to finance through informal savings groups, mobile money and mobile banking.

Financial Institutions

Commercial banks, SACCOs and Micro-Finance Institutions (MFIs) provided payment services, credit products, savings products and insurance products to dairy farmers in Githunguri and Olenguruone. To enable dairy farmers to invest in CSA, commercial banks preferred to utilise non-specific financial products, whereas SACCOs and MFIs were experimenting with specific financial products for CSA investments. The latter, though not all SACCOs and MFIs, therefore, established formal relationships with suppliers of biodigesters and water tanks (Figure 2).

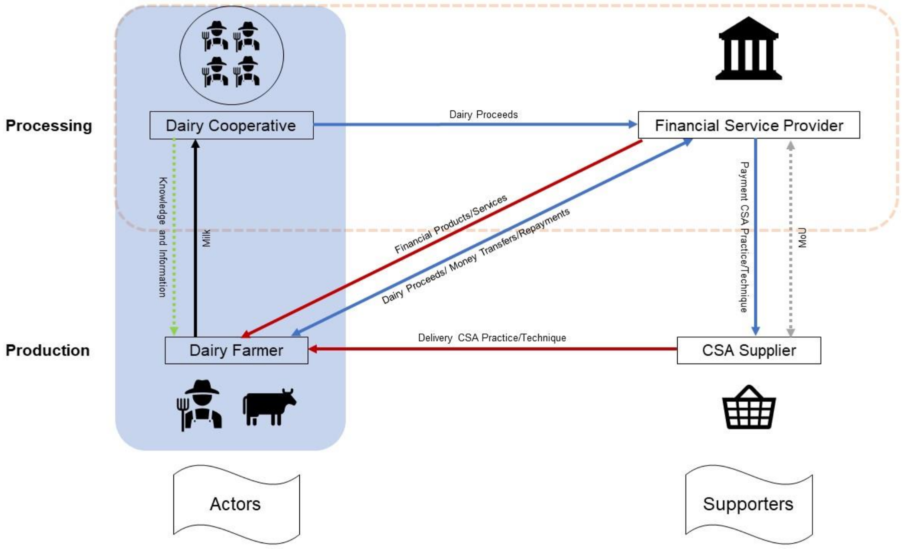


Figure 2. *Bilateral Agreements between Financial Institutions and CSA suppliers in the Dairy Value Chains in Githunguri and Olenguruone*

Arguments whether to develop specific financial products for CSA were related to:

- demand for specific financial products for CSA;
- awareness about CSA among dairy farmers;
- target groups of financial institutions;
- and adoption and resilience to a changing climate and culture in Kenya

Financial institutions were in a position to stimulate the adoption of CSA among members of GDFCS and ODFCS. However, due to a lack of cooperation in the dairy value chains, not all opportunities were exploited by financial institutions that operated in Githunguri and Olenguruone.

Value Chain Finance

Both GDFCS and ODFCS aimed to integrate operations and services of other chain actors, e.g. collecting, processing and marketing milk, besides supply of dairy inputs, access to finance, artificial insemination and extension services into the operations of the dairy cooperatives. To enhance the adoption of CSA, both dairy cooperatives should consider applying the principles of 'value chain finance' to improve cooperation in the dairy value chains, to address awareness about CSA, to market CSA products and to promote specific financial products for CSA. In the case of GDFCS and ODFCS, a tripartite arrangement between the dairy cooperatives, CSA suppliers and financial institutions will enhance the adoption of CSA (Figure 3). By doing so, all chain actors will establish a common agenda and align interests, improve communications and manage risks that come with the adoption of CSA (KIT & IIRR, 2010).

Relevance to the CSDEK project

Previous studies of CSDEK focussed on identification of value chain actors and supporters in the dairy chains; the creation of business models to enhance the adoption of CSA; analysis of carbon footprints of dairy farmers, farming practices and gross margins of dairy farmers, knowledge about CSA; and feed value chains (Baars, et al., 2019). So far, however, financial practices of dairy farmers, and the financial environment in which these dairy farmers operate their businesses, remained a black spot for CSDEK. This study was a first attempt to understand financial practices of dairy farmers and expose the role of financial institutions in Githunguri and Olenguruone, to bolster the development of inclusive and climate smart business models for dairy farmers in Ethiopia and Kenya. Furthermore, the study complements the findings of Odhong et al. (2019) and Wilkes et al. (2019).

In order to scale up the adoption of CSA practices and techniques, and apply value chain finance (Figure 3), this study recommends that:

1. Dairy cooperatives, financial institutions and CSA suppliers develop, increase or enhance extension services and marketing related to CSA
2. Dairy cooperatives, financial institutions and CSA suppliers get together and align their interests to create a common agenda that aims to stimulate the adoption of CSA
3. Dairy cooperatives, financial institutions and CSA suppliers should develop incentives for dairy farmers to stimulate the adoption of CSA.

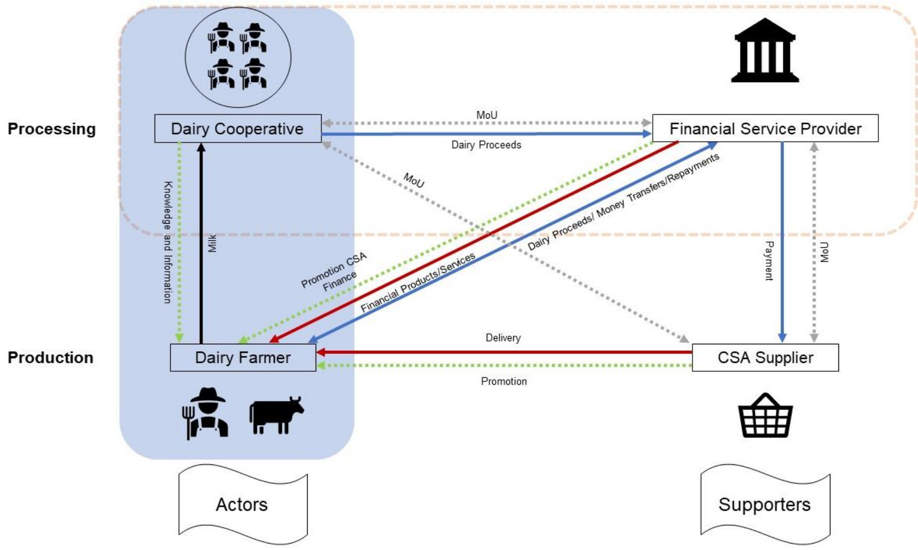


Figure 3. *Tripartite arrangements between dairy cooperatives, financial institutions and CSA suppliers to stimulate the adoption of CSA in Githunguri and Olenguruone.*

References

Baars, R., M. Verschuur, R. Eweg and J. de Vries (2019). *Practice briefs: Inclusive and climate smart business models in Ethiopian and Kenyan dairy value chains.* Velp: Van Hall Larenstein University of Applied Sciences.

Kiiza, A. (2018). *Scaling Up Climate Change Mitigation Practices in Smallholder Dairy Value Chains: A case study of Githunguri Diary Farmer Cooperative Society Ltd, Kiambu County, Kenya.* Velp: Master thesis - Van Hall Larenstein University of Applied Sciences.

KIT & IIRR (2010). *Value Chain Finance: Beyond microfinance for rural entrepreneurs.* Amsterdam: Royal Tropical Institute; Nairobi: International Institute of Rural Reconstruction.

Odhong, C., Wilkes, A., van Dijk, S., Vorlaufer, M., Ndonga, S., Sing'ore, B., & Kenyanito, L. (2019). *Financing Large-Scale Migitation by Smallholder Farmers: What Roles for Public Finance?* s.l.: Frontiers Sustainable Food Systems.

Sanden, W. van der, 2020. Financial construction for dairy farmers adopting climate smart agriculture in the case of Githunguri and Olenguruone dairy farmers cooperative societies in Kenya. Velp: Van Hall Larenstein University of Applied Sciences, Bachelor thesis International Development Management.

Wilkes, A., Odhong, C., Ndonga, S., Sing'ora, B., & Kenyanito, L. (2019). *Acces to and supply of finance for enhancing dairy productivity.* Wageningen: CGIAR Research Program on Climate Change, Agriculture, and Food Security.

More information...

Want to know more about research at Van Hall Larenstein? Visit our website **www.vhluniversity.com/research** for information about our professorships, projects and more.

Want to know more about study programmes at Van Hall Larenstein? Visit our website **www.vhluniversity.com/study** for information about our master and bachelor programmes and more.

---

van hall larenstein
university of applied sciences

Leeuwarden
Agora 1
P.O. Box 1528
8901 BV Leeuwarden
The Netherlands
Phone +31 (0) 58 284 61 00

Velp
Larensteinselaan 26a
P.O. Box 9001
6880 GB Velp
The Netherlands
Phone +31 (0) 26 369 56 95