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The effects of economic and environmental strategies on typical dairy farms performance in Western Kenya

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Abstract

Dairy farming makes a substantial contribution to economic and social development. Globally, milk production employs around 150 million people (Anand *et al*., 2022). The dairy industry, predominantly smallholder in East Africa, is the most developed of the livestock sub-sectors. Increased demand for animal-sourced food might support smallholder crop-livestock farmers in engaging in market-oriented economic activities by expanding livestock production practices. In Kenya livestock industry contributes to 30% of the global GHG emissions and expected production growth will come along with increasing emissions (Khatri-Chhetri *et al*., 2022). The study region is Western Kenya. This region's rainfall is bimodal, with long rains from March to June and short rains from September to December. As a result, each year has two full cropping seasons. The majority of farms are mixed crop-livestock farms, with a focus of the main economic activities on sugarcane, corn, sorghum and dairy. Rainfall, on the other hand, is exceedingly variable and unpredictable, resulting in crop losses and food insecurity. Based on a farm survey among 40 mixed crop-dairy farms in Vihiga county typical farm data sets were set up for the purpose of determining the effects of greenhouse gas mitigation on typical dairy farms 'performance. These data sets included the herd structure, the animal performance, feeding strategies and land use. The criteria for selecting typical farms were based on: number of dairy cows, animal production systems, breed and crop production. Greenhouse gas emissions estimation for the dairy enterprise and related crop and forage production will be applying IPCC methodology tier 2 following 2019 IPCC guidelines. The study aimed to assess the effects of greenhouse gas mitigation strategies on farm economics and greenhouse gas emissions. The study contributed to a flagship project of the Global research alliance on agricultural greenhouse gases (GRA) called Economics of GHG mitigation at farm level in global cattle production systems.

Keywords: Climate change, dairy farms, greenhouse gas emissions

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Introduction

The dairy industry, predominantly smallholder, is the most developed of the livestock sub-sectors in East Africa where the main source of marketed milk is produced primarily by exotic and cross-bred dairy cattle (Bateki *et al*., 2020). It is frequently stated that increased demand for animal-sourced food can assist smallholder crop-livestock farmers in engaging in market-oriented economic activities by intensifying livestock production practices (Abera *et al*., 2022). The increased demand for livestock products has generated a multifunctional landscape, because total global anthropogenic GHG emissions, it is also a substantial contributor to global warming (Cheng *et al*., 2022). The main sources of GHG emissions from dairy farming are methane (CH_4) from enteric fermentation and manure, nitrous oxide (N_2O) from excreta and feed production as well as carbon dioxide (CO_2) from energy-use and land-use change. (Singaravadivelan *et al*., 2023). Furthermore, Kenyan agriculture contributes about 40% of the national greenhouse gas emissions (Dal Maso *et al.*, 2020). Moreover, by 2030 Kenya is committing to reduce the GHG emission by 32% (Government of Kenya, 2020). To achieve this goal there is a need for collaboration from the various stakeholders to reduce GHG emissions. Therefore, the aim of this study is to determine the effects of economic and environmental strategies on typical dairy farms performance in Western Kenya.

Material and Methods

Data was collected through a survey of mixed crop-dairy farms in Vihiga county in 2022. Vihiga county is dominated by intensive dairy systems and located in Western Kenya close to Lake Victoria as shown in Figure 1.

Figure 1: Map of study area

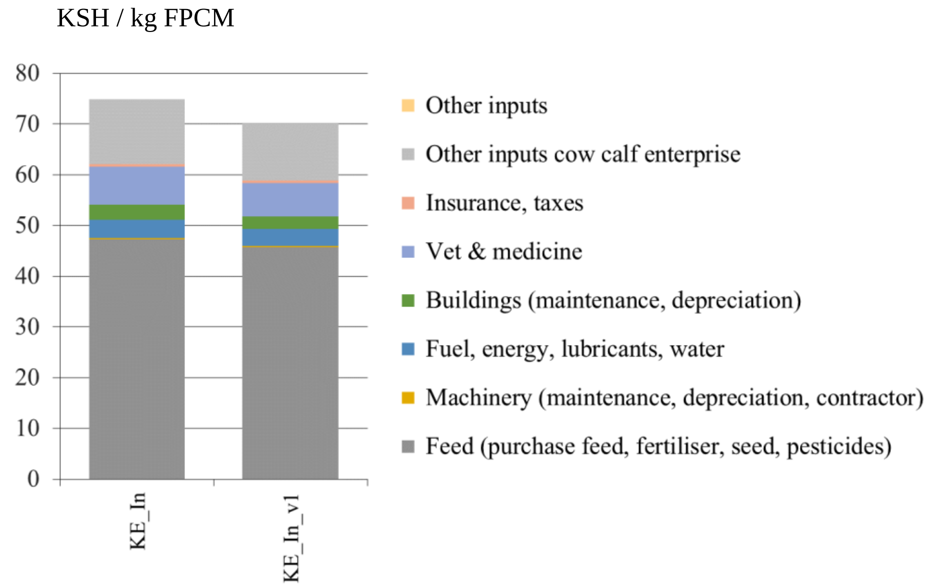
Expert knowledge and relevant literature (Feedipedia, SSA Feeds (ILRI 2020)). were consulted for feed composition and characteristics data.
One typical dairy-intensive production system was identified based on the characteristics shown in Table 1.
The TIPI-Cal tool (Deblitz n.d.) was employed for the economic analysis of dairy production and to estimate the GHG emissions at the farm level in a mixed crop-dairy system following the IPCC 2019 refinement guidelines, Tier 1 and 2. Two scenarios have been analysed, "baseline scenario" with no change in the production system and "improved scenario" with a change in feedstuff to mitigate GHG emissions, i.e. sugarcane residues are replaced by bought-in forage. And the milk production was assumed to increase by 1 litre per day according to Arndt *et al*. (2022).

Table 1: Characteristics of the typical dairy-intensive production system in Vihiga

Characteristics	Intensive system
Location	Vihiga
Breeds	Exotic/cross
No. of cow	11
Milk yield (kg/cow/year)	2,529
Feeding type	Sugarcane residues, concentrates, forages
Crops	Maize, Beans, Banana
Manure management	Solid storage – covered

Results and Discussion

Farm economic analysis results are shown in Figure 2 below.



Note: KSH = Kenyan Shilling, FPCM = fat and protein corrected milk

Figure 2: Costs of production per kg FPCM, 2022 price data: 100 KSH = 1 USD

The on farm feed production decreased due to the introduction of bought in-forages in (KE_In_v1). Figure 2 shows the production costs for the baseline scenario (KE_In) and the improved scenario (KE_In_v1). In both scenarios feed costs represent the biggest part of the total non-factor costs, i.e. 63% (65%) in the baseline scenario (improved scenario). Replacing sugarcane residues with bought-in forage resulted in a 6% decrease of production costs per kg fat and protein corrected milk (FPCM). At whole farm level, this lead to an increase in direct costs by 6%, but returns through higher milk yield increased by 9%.

The GHG analysis in Figure 3 shows that in the baseline scenario the methane emissions from enteric fermentation represent the highest share of GHG emissions per kg FPCM. Moreover, nitrous oxide and methane emissions from manure are low due to the type of manure management (solid storage – covered).

When replacing the low-quality feed from crop residues (baseline scenario, KE_In) with bought in forage, i.e. high quality feed (improved scenario, KE_In_v1), the enteric methane emissions reduce by 11%.

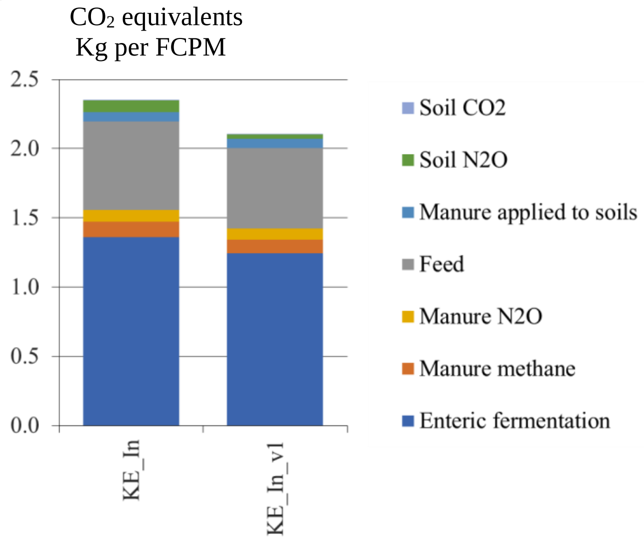


Figure 3: GHG emissions per kg FCPM

The decrease in GHG emission intensity was mainly through an increase in milk production. Furthermore, introducing high quality feed does not only increase milk production but also effects the animal's body weight gain.

Conclusions and Outlook

- Shifting from low quality feed (surgarcane residue) to bought in-forage does not only reduce methane emission, but also increases farm profit as well as animal performance.
- GHG mitigation strategies can incur additional costs, that farmers need to be aware of.

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