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# Policy Brief:  Evaluation of scenarios for improving the collection system for a milk factory in Ethiopia

Combination of a simple model, economic analysis, and the effect on GHG emissions.

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## I. Background information

Farming communities in developing countries often lack the infrastructure to sufficiently safeguard their perishable produce from deterioration before it can be sold. Depending on the local settings, completely different technical, logistic, or infrastructure options might be proposed to prevent deterioration. Specifically for milk, which is obviously prone to rapid bacterial spoilage when left uncooled, several interventions have been suggested and implemented over the years to improve the situation. Notably in Kenia and Ethiopia, various NGOs have installed refrigeration units at collection points near central roads where electricity is available. Alternatively, various off-grid cooling options have been technically developed to prevent spoilage for part of the milk production already at the farms.

In Ethiopia, 98% of the milk is produced by smallholder farmers (Getahun et al., 2019). On average, in peri-urban areas, farmers possess 3.8 cows, which produce about 17 liters of milk per day (Vernooij et al., 2010).
Part of this production is collected and transported to milk factories, where the milk is pasteurized or further processed into yogurt, butter or cheese for upper-class consumers in larger cities.

One of these factories is the Zagol milk factory, located in Sululta, a one-hour drive north of Addis Ababa, the capital of Ethiopia. The factory has a maximum pasteurization capacity of 1000 litre per hour, but it currently processes only 2000-3000 litres a day.
The milk and other dairy products from the factory are sold in Addis under the brand name Zagol. According to the factory, the product demand is sufficiently large to sell more than the current production allows for. The challenge for the factory, therefore, is to increase its supply of milk by improving the milk collection process.

The storage at smallholder farms, the collection of milk and the transport to the factory are commonly done at ambient temperature. As a result, only the morning milk is collected, because only then is the time between milking and arrival at the factory short enough to prevent quality loss. Nevertheless, a part of the milk arriving at the factory is still not suitable for further production and will be rejected due to its low quality.

Dairy accounts for 6.8% of total FLW worldwide and 10.2% of the associated GHG emissions (Guo et al., 2020). This makes saving in the dairy sector relevant to reducing GHG emissions on a worldwide basis.
However, in Ethiopia, rejected milk is not thrown away but used for the production of fermented local products such as ergo, ayib, butter and whey (Andualem and Geremew, 2014). For this reason, this milk cannot be seen as waste. In Ethiopia only about 1.6% of milk is wasted, mainly by spillage (Lore et al., 2005). In this light, it is to be expected that the GHG emissions related to collecting milk will increase rather than decrease, although in favour of economic growth and improved product quality.

The goal of this study was to determine the best cooling scenario to prevent milk rejection and increase the milk collection potential for a milk factory in Ethiopia.

## II. Setup of this study

This study combined a quality models with locally realistic logistic scenarios as a practical way to assess the feasibility of various options. The analysis addresses four common criteria when evaluating the implementation of these scenarios: (1) the effect on the potential yield of good quality milk; (2) the cost-effectiveness; (3) the effect on total greenhouse gas (GHG) emissions; and (4) the technical feasibility and practical and economic consequences. This way of comparing scenarios can hopefully contribute to better implementation of interventions that can genuinely improve the lives of smallholder farmers and stimulate economic growth for them.

## III. Policy advice based on this study

The applied combination of a simple model, economic analysis and the effect on GHG emissions gives valuable information on the effectiveness and limitations of different scenarios for improving the supply chain. This can help to successfully apply a scenario and thereby the economic development of a specific region.

## IV. Main findings from this study

The developed milk quality model shows that the rejection rate for milk collected in Ethiopia is largely dependent on the time between milking and cooling. Only improving farm hygiene will not reduce the rejection rate of evening milk to acceptable levels. The analysis of the scenarios (table 1) shows that cooling is essential for preventing rejection of collected evening milk in the area of the Zagol milk factory. For the morning milk, cooling is currently less beneficial, but only when the time between collection and arrival at the factory is limited.
Including economics (table 2), the best scenario can be expected with a cooling centre where farmers offer their milk twice a day. The additional collection cost for milk will be just below USD 0.01/L above the current price for morning milk, and this depends on the amount of milk the farmers are offering. However, as it is expected that farmers will not be willing to deliver the evening milk to the chilling centre themselves at night, an additional collecting system is probably needed to increase the milk supply. This would result in higher costs and a risk of rejection at the factory gate. Furthermore, when a collection system can be set up, a chilling centre has reduced added value. Therefore, with a collection system at farms for the evening milk, the milk can be better brought directly to the factory. The rejection rates in that case are still significant. However, they can be reduced by limiting the collection time. Another benefit for this scenario is that it can be introduced on a small scale with limited financial risk.
In addition, the off-grid chiller scenario, where the rejection rate is reduced to zero, can be started as a small project with limited risk. Compared to a farm collection system, the collection cost for this scenario is much higher. However, this scenario is the only one where a reduction of GHG emissions is expected.
If a grid extension was established, the cost for on-farm cooling would be much lower, compared to the solar-power-driven cooler. The drawback is that proper training would be necessary to get sufficiently high cooling rates for the evening milk, in order to prevent rejection at the collection point in the morning.

Except for solar power-driven cooling on the farm, all scenarios have higher GHG emissions than the current situation. Although they have only little impact, as the additional GHG emissions account only for 0.2-2.2% of the GHG emissions of primary production.

**Table 1.** Estimation of milk samples that do not pass alcohol test at collection from farmer and arrival at factory gate in the morning for different scenarios.

| | | rejection of milk samples (%) | |
|---|---|---|---|
| **Scenario** | | | |
| **morning milk** | | collection from farmer | factory gate |
| **A1** | current situation | 0% | 1% |
| **B1,C1,D1** | chilling centre | 0% | 0% |
| **evening milk** | | | |
| **A2** | current situation | 88% | 96% |
| **B2** | chilling centre, no extra delivery | 88% | 90% |
| **C2** | chilling centre, delivered by farmer | 0% | 0% |
| **D2** | chilling centre, collected by scooter | 0% | 2-10%* |
| **E2** | direct to factory, collected by scooter | 0% | 5-13%* |
| **F2** | off-grid cooling at farm | 0% | 0% |
| **G2** | refrigerator cooling at farm | 7% | 11% |

*First rejection rate calculated with optimistic numbers, second with conservative numbers.

**Table 2.** Additional depreciation, variable and average cost per litre for collection of 1000 L evening milk per day and average selling amount of 9 L per farm for different scenarios. Depreciation 10 years.

| | | Depreciation ($cent/L) | Variable cost ($cent/L) | | | Total collection costs ($cent/L) |
|---|---|---|---|---|---|---|
| | Scenario | | elec. | gasoline | labour | |
| **morning milk** | | | | | | |
| **A1 E1 F1 G1** | current situation | - | - | - | - | - |
| **B1 C1 D1** | chilling centre | 1.6 | 0.2 | | 1.4 | 0.9 |
| **evening milk** | | | | | | |
| **A2** | current situation | - | - | - | - | - |
| **B2** | chilling centre, no extra delivery | 1.6 | 0.2 | - | - | 0.5 |
| **C2** | chilling centre, delivered by farmer | 1.6 | 0.2 | - | 1.4 | 0.9 |
| **D2** | chilling centre, collected by scooter | 2.6-4.0 | 0.2 | 1.1-1.7 | 3.4-5.2 | 2.0-3.0 |
| **E2** | direct to factory, collected by scooter | 1.0-2.4 | 0.2 | 3.6-4.7 | 2.0-3.7 | 1.6-2.8 |
| **F2** | off-grid cooling at farm | 21 | - | - | - | 5.6 |
| **G2** | refrigerator cooling at farm | 1.9 | 0.6 | - | - | 0.7 |

**VI. References**

This policy brief is based on the scientific publication 'Evaluation of Scenarios for a Milk Factory in Ethiopia' by Dijkink B. et al 2021 https://research.wur.nl/en/publications/evaluation-of-scenarios-for-improving-the-collection-system-for-a

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