Food and Agriculture Organization of the United Nations

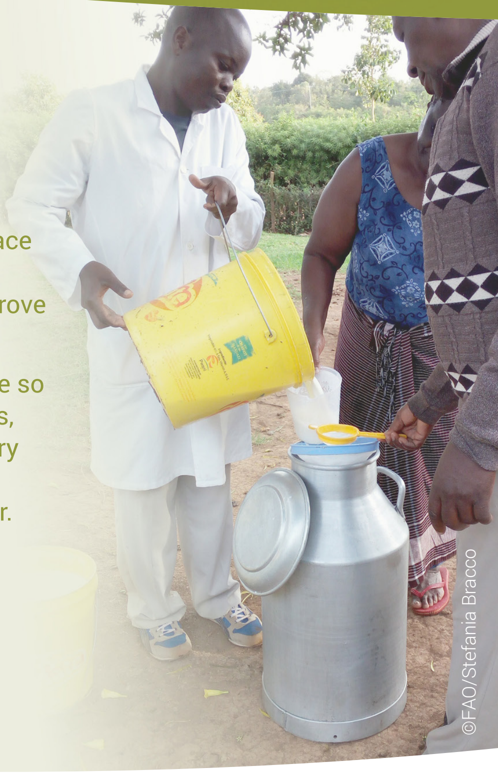
INVESTING IN SUSTAINABLE ENERGY TECHNOLOGIES IN THE AGRIFOOD SECTOR (INVESTA)

COSTS AND BENEFITS OF CLEAN ENERGY TECHNOLOGIES IN KENYA'S MILK VALUE CHAIN

Informal channels handle more than 80 percent of marketed milk. Small dairy farmers face constraints when reducing milk losses and increasing the value of milk sales through improved quality. As most rural farms are off-grid, renewable electricity options can improve milk supply quality, in particular by introducing and then extending the milk cold chain.

The milk cooling technologies assessed as case studies are financially viable, even more so when other externalities are factored in. Conversely, under current regulations and prices, financial returns from investing in medium-scale anaerobic digestion systems using dairy cattle manure feedstock for power generation tend to be negative. This could change if a local market was developed for the digestate by-product for use as an organic fertilizer.

The adoption of clean energy technologies in the milk value chain can be facilitated by regulating and enforcing minimum milk quality standards, introducing a price premium for refrigerated quality milk, establishing a market for digestate, financing support programs and incentives, awareness raising activities, and providing technical assistance and higher quality extension services.



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ENERGY TECHNOLOGIES IN THE KENYAN MILK VALUE CHAIN

70 to 80 percent of the 1.8 million dairy farms in Kenya are smallholdings with three to ten cows. About 7 percent of total milk production is lost, mainly due to spoilage of evening milk on farm. In rural areas, 93 percent of the population does not have access to the rather unreliable electrical grid, and this creates challenges for cooling the milk on the farm. Main barriers include poor transport infrastructure, inadequate milk handling and storage equipment, lack of technical know-how and equipment, no price incentives offered to improve milk quality, poorly trained personnel along the milk supply chain, and lack of market intelligence.

Clean energy solutions can add value to the milk sector as well as the livelihood of dairy farmers. However, barriers to their adoption include limited awareness about the technologies and their benefits and high upfront cost. For instance, lack of awareness on the benefits of producing biogas and digestate results in farmers typically storing manure in uncovered piles under shade or in open areas.

Women's access to inputs and services in dairy farming is restricted by their heavy workloads and limited ability to read and use written information including extension materials. Although dairy cattle are managed by women, they are largely owned by men who are also responsible for selling calves, heifers and cattle.

CASE STUDIES

Three technologies, a) biogas for power generation from dairy cattle manure, b) biogas domestic milk chillers and c) solar milk coolers of about 600 l capacity were selected as case studies of clean energy technologies that can be introduced in Kenya.

Although uncommon, some large dairy farms keep cattle in feedlots overnight, thus making the collection of manure easier and cost effective as the feedstock for a **biogas digester for power generation**. The technical potential of this technology in Kenya was estimated to be 31 systems.

Conserving the quality of evening milk is often challenging. As the vast majority of small-scale rural farms are off-grid, using locally produced **biogas** to run **domestic milk chillers** of around 10 l capacity is an interesting option that could benefit around 1.2 million small farmers.

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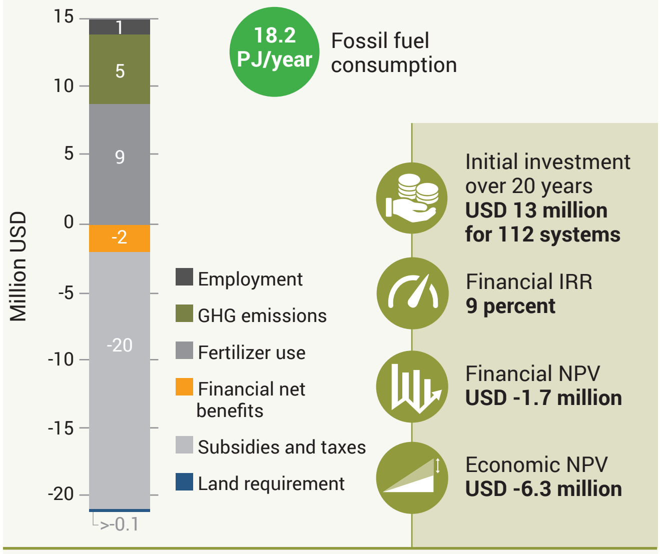
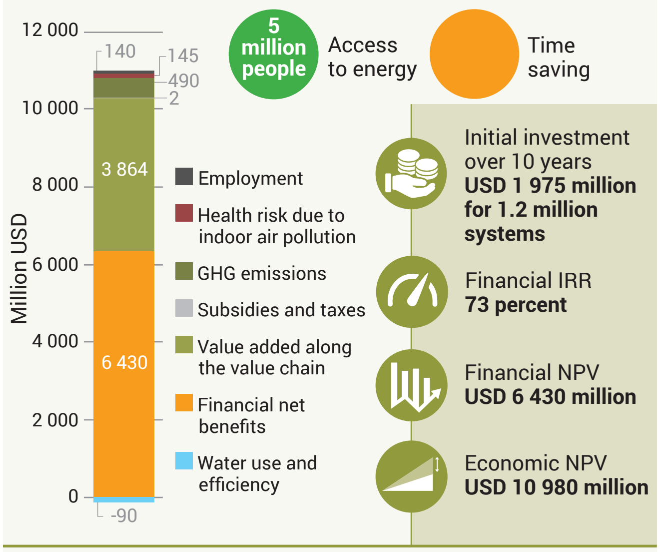
Solar milk coolers can be adopted by farmer groups and associations to cool the milk before processing in the value chain. About 125 milk collection points with a capacity of around 600 l/day each are currently off-grid or located in areas with an unreliable electricity supply.

FINANCIAL VERSUS ECONOMIC ATTRACTIVENESS OF THE CASE STUDIES

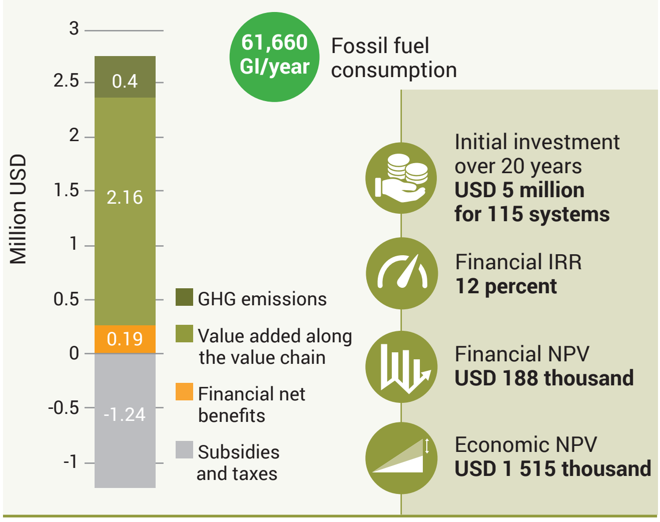
Biogas for power generation (150 kWel capacity)



Biogas domestic milk chiller (10 l capacity)



Solar milk coolers (600 l capacity)



Note: NPV: net present value; IRR: internal rate of return. Non-monetized impacts are depicted as circles (green: positive, orange: variable, red: negative impact) and quantified where possible.

They could benefit from replacing diesel generators with solar milk coolers.

Both biogas and solar cooling technologies can significantly reduce milk loss and add value along the chain by increasing the quantity and quality of milk that enters the formal channels.

Based on the current value of digestate, both the financial and economic net returns of biogas power generation plants are negative; despite the existing Feed-in-Tariff for biogas plants, and the socio-economic and environmental co-benefits in terms of digestate use, GHG emissions avoided, employment creation and reduction in fossil fuel consumption. The creation of a market for the digestate would make biogas technologies more financially appealing.

Conversely, at small-scale, domestic biogas milk chillers have very positive returns, mainly due to the additional revenue from the milk sold, the value of the digestate as a fertilizer, the savings of fuelwood for cooking where there is surplus biogas used for cooking, employment creation and improved access to energy.

Similarly, the main benefits of the solar milk coolers concern reduction in milk loss and savings from the avoided purchase of diesel fuel. However, without a price premium for cooled milk, the payback period exceeds 15 years. Without strict milk quality standards at collection stage and a price premium for refrigerated quality milk, the investment in cooling technologies is not very appealing. Adding value in the formal milk sector would justify such interventions.

POSSIBLE SUPPORT INTERVENTIONS

Public, private and financial actors can facilitate the adoption of clean technologies by:

- regulating and enforcing **minimum milk quality standards** at milk collection points;
- establishing **codes and standards** to boost confidence in the use and trade of digestate to help develop a local market;
- facilitating the procedure for the **power purchase agreement** (PPA) for renewable energy producers;
- developing **financing programmes** and financial incentives to make energy technologies more affordable (such as government-backed financial mechanisms or preferential loans, low interest subsidized loans, loan guarantees, or technical assistance funds);
- facilitating business opportunities in the dairy sector, in particular for **young and women farmers**;
- introducing a **price premium for cooled quality milk**;
- establishing **awareness raising and capacity development activities** about the benefits of clean energy options for agrifood to private companies, officials, financing institutes and dairy farmers; and
- facilitating **technical assistance** to public officials to ensure that they offer high quality extension services to meet the needs and expectations of the technology end-users.

For more information on the INVESTA project and a description of the case studies please visit:
www.fao.org/energy/agrifood-chains/investa

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