Cost–benefit analysis of fodder production as a low emissions development strategy for the Kenyan dairy sector

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Cost–benefit analysis of fodder production as a low emissions development strategy for the Kenyan dairy sector

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Acronyms and abbreviations

CH4	Methane
CO2	Carbon dioxide
DFID	UK's Department for International Development
EADD	East Africa Dairy Development
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross domestic product
IFAD	International Fund for Agricultural Development
IFC	International Finance Corporation
IFCN	International Farm Comparison Network
ILRI	International Livestock Research Institute
KAAA	Kenya Agribusiness and Agroindustry Alliance
KMT	Kenya Markets Trust
N20	Nitrous oxide
PCC	Per capita consumption
SNV	Netherlands Development Organisation
TMEA	Trade and Markets East Africa (TradeMark East Africa)
USAID	United States Agency for International Development

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Executive summary

Livestock production is a promising agricultural sector to explore in view of achieving greenhouse gas (GHG) emissions reduction, given that it is the largest source of emissions from agriculture. The combination of economic importance and high emissions intensities makes the Kenyan livestock sector a good opportunity for investment in low emissions development strategies.

Ten low emissions development (LED) interventions for the livestock sectors in Kenya and Ethiopia were reviewed in a previous study (Ericksen and Crane 2018). From these, one intervention was selected for further analysis—improving availability of quality feeds for the smallholder dairy subsector, specifically by improving forages. The rationale for this is that access to adequate feed availability and quality are a prerequisite to any other productivity improvements such as improved breeds. The intervention is most suited to intensive and semi-intensive dairy because it requires collection and, ideally, storage of fodder to feed to animals that reside on farms, with limited grazing.

Currently, intensive and semi-intensive dairy production produce about 65% of the total emissions from dairy production. Improved fodder, especially if combined with legumes or dairy concentrates, could reduce emissions intensities per animal or litre of milk by up to 30%.

Stimulating more livestock producers to invest in improved fodder production will require external investments, as the current rates of adoption are very low. Here we outline a clear articulation and rationale for investment in improved forage production and use by smallholder dairy producers, as well as a feasibility assessment of such an investment. We look at two levels of investment—by farmers themselves and for project implementation.

We present a business case as follows. First, we present the overall economic context of Kenyan smallholder dairy production. Second, we detail an analysis of the possible profits to be made at farm level, based upon data collected from field visits with farmers in five counties. Third we evaluate what would be required to make an investment in a project to support yield positive returns over a five-year time span. Last, we review the role of other value chain actors and the support they might provide.

The farm level modelling suggests that there are considerable improvements in productivity and profitability to be made across the five counties if farmers were to invest in on-farm fodder production. In three of the counties this is true even in the low price and production scenario. At the level of a project across three of the counties, the results show that after the second year, the project's benefit would be greater than the annual investment cost assuming minimal risk. We caution that a lot of extension support on fodder production, together with support to develop fodder markets, would also be needed. Currently, neither cooperatives nor the large processors are providing as much support as they could in this area.

1. Rationale for the business case

Livestock production is a promising agricultural sector to explore in terms of how to achieve GHG emissions reduction, given that it is the largest source of emissions from agriculture. Although in Africa total emissions are lower than in Organisation for Economic Co-operation and Development (OECD) countries, the sector is growing rapidly and emissions intensities per unit of animal product are very high (Herrero et al. 2013). Within Kenya, the livestock sector contributes about 12% to GDP and 40% of agricultural GDP (Behnke and Muthami 2011). Kenya has one of the largest dairy sectors in sub-Saharan Africa, contributing 8% of GDP (Odero-Waitituh 2017). The combination of economic importance and high emissions intensities makes the Kenyan livestock sector a good opportunity for investment in low emissions development strategies.

A review of relevant Kenyan policies on climate smart agriculture and livestock development shows commitment to making livestock production more "climate smart" as well as improving productivity in the sector. The recent Kenya Climate Smart Agriculture Framework Program (2015), which seeks to align economic development priorities of Kenya Vision 2030 with climate change goals, highlights several points for livestock. First, sustainable intensification and agricultural transformation to increase the productivity of livestock are mentioned. Second, component 2 of the framework focuses on key agricultural value chains including livestock. The priority interventions are breed improvement, low emissions technologies and practices, disease surveillance and improved nutrition. The Climate Smart Agriculture Strategy (2017), which speaks more to implementation, also highlights GHG emissions from livestock, specifically mentioning the high intensities from enteric fermentation due to low quality feeds and poor husbandry. Livestock is targeted for Nationally Appropriate Mitigation Actions (NAMA) that provide support for intensification of production. The proposed NAMA for the dairy sector (2017) specifically mentions increased commercial production of fodder combined with more access to extension services focused on productivity interventions.

In low productivity livestock systems such as those found in east Africa, there is great potential to reduce emissions intensities (GHG per unit of product) from improving individual animal productivity. Ten LED interventions for the livestock sectors in Kenya and Ethiopia were reviewed in a previous study (Ericksen and Crane 2018). From this study, we decided to choose one intervention for further analysis—improving availability of quality feeds for the smallholder dairy subsector, specifically by improving forages. Napier grass is the most commonly grown perennial fodder in the smallholder dairy sector in Kenya, with between 21 and 93% of farmers growing it, depending on the exact location (Lukuyu et al. 2011, ILRI unpublished data). The rationale for this is that access to adequate feed availability and quality are a prerequisite to any other productivity improvements such as improved breeds. This was confirmed in interviews with farmers, representatives from the Ministry of Agriculture, Livestock and Fisheries as well as ILRI's feed and animal nutrition experts. Other dietary supplements are only effective with adequate basal diet. Limited availability and access to high quality feeds is one of the main constraints to improving livestock productivity (Owen et al. 2012).

The intervention is most suited to intensive and semi-intensive dairy because it requires collection and, ideally, storage of fodder to feed to animals that reside on farms, with limited grazing.

FAO and New Zealand Agricultural Greenhouse Gas Research Centre (NZAGGRC) (2016) estimate that the intensive and semi-intensive production systems together produce 65% of the total emissions (12.3 million tonnes

CO2eq) from dairy production. Estimates of potential to reduce GHG emissions intensities through improving quality and quantity of feed range from 8 to 24 % in intensive and semi-intensive dairy systems in Kenya (FAO and New Zealand Agricultural Greenhouse Gas Research Centre 2017), depending upon whether the fodder is supplemented with legumes, sweet potato silage or dairy concentrates. A newer and more spatially explicit analysis (Brandt et al. 2018) suggests that combining increased use of the most common improved forage—Napier grass—with dairy concentrates, could reduce emissions intensities in the Kenya dairy sector by 26% to 31%. An estimated 1.4 million smallholder farmers are engaged in dairy production, with an overall herd size of 4.3 million animals.

Stimulating more livestock producers to invest in improved fodder production will require external investments as the current rates of adoption are very low. Ericksen and Crane (2018) noted that the key constraints farmers face to improving fodder production are lack of available land, limited capital to invest and limited availability of high quality forage seed. They also found that lack of sufficient commercial orientation/opportunities overall is a constraint against "upgrading" of feed and forage practices. Many smallholder farmers keep livestock as a complement to crop production, and as such, dairy is not the core business.

Here we outline a clear articulation and rationale for investment in improved forage production and use by smallholder dairy producers, as well as a feasibility assessment of such an investment. We look at two levels of investment—by farmers themselves and for project implementation. It is understood that while the private sector may be involved in supporting various value chain actors, there is currently a need for significant public sector intervention/ investment to make the initiative viable[1]. As Kenya is now committed to including livestock in its Nationally Determined Contribution and has a NAMA proposal for the dairy sector which includes improvements in fodder quality and availability, this investment plan is timely and of interest to a range of investors. The Kenya Climate Smart Agriculture Strategy highlights the need to attract finance to realize Kenya's mitigation targets.

The business case contains the following key elements:

1. A clear assessment of the economics and profitability of fodder production within the dairy value chain focusing on farmers; input suppliers (both agronomic supplies and financial services); and other value chain actors including cooperatives, processors, and traders where relevant.

2. A clear articulation of the proposed intervention needed to achieve scale.

3. A feasibility assessment of the proposed intervention (costs, benefits and risk assessments) which provides a clear articulation of both public and private investment requirements.

1 This investment could include actual funding or changes to the policy regime that make the intervention viable/more attractive.

2. The economic context for dairy development

2.1 Kenya's dairy industry

The dairy industry in Kenya is one of the largest in Sub-Saharan Africa and is worth about KES170 billion (USD2 billion), accounting for 14% of agricultural output and 3.5% of the total GDP[2]. Key figures on the sector are presented below.

Kenya's dairy sector in figures (2011–2016)	
Agriculture share of exports	65%
Dairy sub-sector share of Kenya GDP	4%
Dairy sub-sector value	KES 170 billion (USD 2 billion)
Total milk production	5 billion (kg) litres
Milk production by smallholders	80%
Processed to raw milk market	3:7
Smallholder dairy farmers	1,400,000
Medium and large-scale dairy farmers	3,500
Milk consumption per capita	115 liters per annum
Active major milk processors	30
Market leading milk processors	Brookside, New KCC
Direct economic impact of dairy sub-sector	Employs 1.8 million people

Source: USAID and Climate Focus 2018

Dairy is the fastest growing sub-sector of Kenyan agriculture. In 2013, the Kenya Dairy Board reported an annual growth rate of 6% in the volume of milk processed driven by increased investment in production, processing and marketing over the last few years, increasing the country's capacity to process milk[3]. Average milk production ranges from 4 to 69 litres per cow per day.

The value-chain actors in the Kenyan dairy industry are:

i. farmers

ii. input service providers (agricultural vets, extension officers, artificial insemination (AI) and pest control)

iii. animal feeds processors

iv. producer associations/cooperatives

v. transporters and marketers

vi. milk processors (milk value addition)

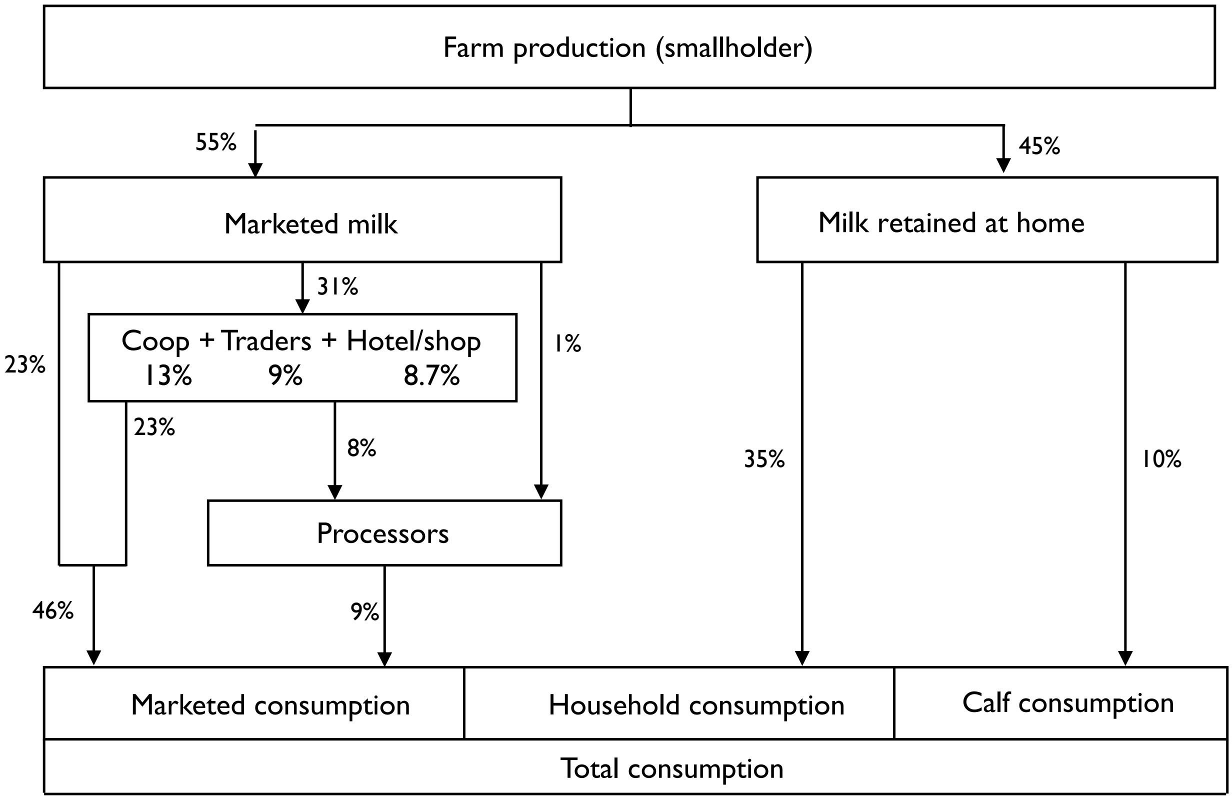
2 Kenya Ministry of Agriculture 2015

3 Kenya Dairy Board—http://www.kdb.co.ke/component/content/article/30-kdb-latest-news/229-over-520-milliom-litres-of-milk-processed-in-2013

vii. wholesale and retail traders

viii. consumers

Figure 1: The value chain of smallholder farmer milk marketing channels in Kenya



Source: Muriuki 2011

Kenya currently produces about five billion kg of milk annually, of which 4.5 billion kg (100 kg per capita per annum) is consumed domestically. The daily milk output per cow is 5-10 litres. Only 10% of milk output is formally processed and up to 9 out of 10 litres of milk is marketed through informal channels. With a per capita consumption rate of 110 litres, Kenya is ranked the sixth highest in Africa but 86th in the world. In East Africa, Uganda and Tanzania had a per capita consumption of 23 litres each while Rwanda's consumption is 15 litres per person per year.

Despite these high levels of consumption and an industry that is growing with significant private sector engagement, many smallholder producers are not optimizing their production. Key issues are; limited skills among smallholder farmers, low level of commercialization by smallholders, high input cost and seasonality of raw milk production due to low ability to produce and preserve quality fodder, low value chain actor linkages for efficiency and lack of credible input suppliers and service providers.

2.2 Characteristics of dairy production systems

Dairy farming in Kenya is concentrated in the high altitude agroecological zones of the central highlands and Rift Valley regions with a high and bimodal rainfall and relatively low temperatures between 15^{o}C and 24^{o}C. More than three-quarters of the households in the two regions engage in agriculture with 73% practicing integrated crop/dairy production. Slightly over half (54%) of smallholder faming households holding up to one acre of land keep cattle. In 2015, the Kenyan dairy cattle population was estimated at 4.3 million and produced over 3.43 billion litres of milk. Smallholder dairy farmers accounted for over 80% of the total national milk output. In 2007, the Ministry of Livestock Development estimated that the national dairy cattle herd was made up of 50% cows, 10% heifers of over one year, 11% heifers of less than one year, 17% bulls and bull calves and 12% steers. This has not changed significantly. The main dairy producing breeds are Friesian, Guernsey, Ayrshire, Jersey and their crosses.

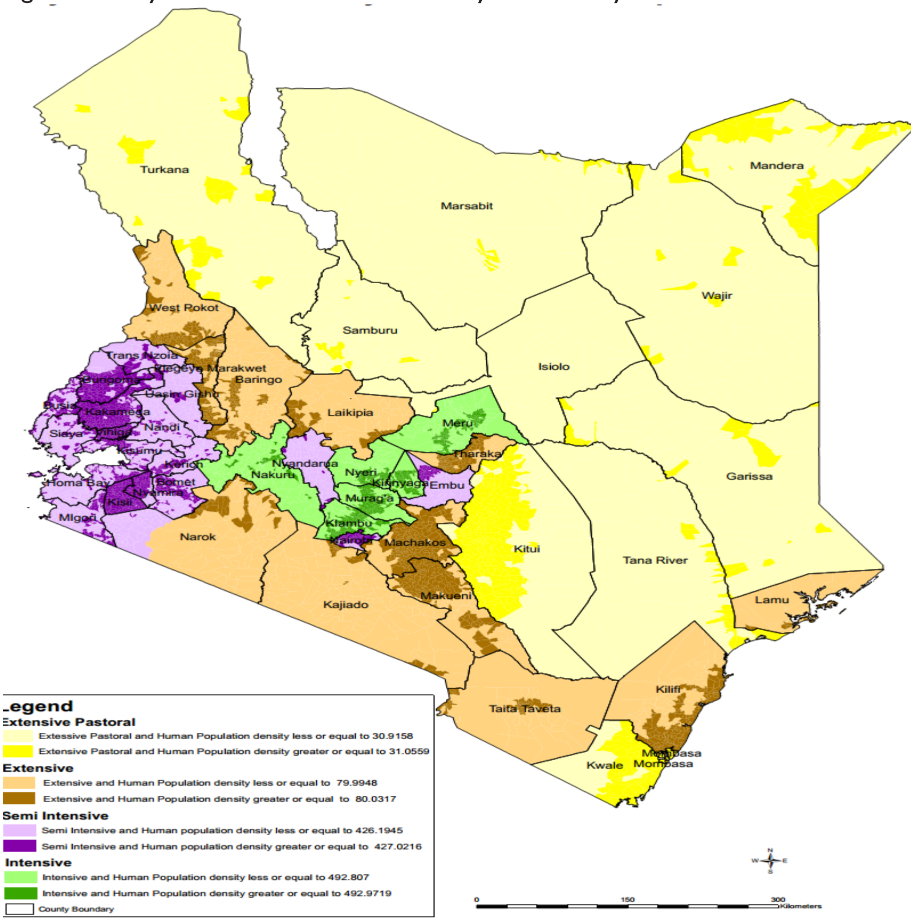
Dairy cattle are kept under intensive and semi-intensive production systems, with the distinction made between the two based on size, level of management and use of inputs. In places with higher population density, many keep their animals confined on farm and stall-feed them crop residues and planted fodder. Smallholders using these more intensive systems for dairy production typically produce on a few acres only—usually less than three—with a herd size of one to five pure or crossbred cows or a mixture of both[4]. Less intensive systems combine stall-feeding and some grazing. In this business case, we focus on the zero-grazing farmers.

Table 1: Characteristics of typical farmers practicing zero-grazing

County	Nakuru	Kisii	Kamkamega	Bomet	U/Gishu	Average
Scale	Small	Small	Small	Small	Small	--
Total cows	4	4	4	5	5	4
Lactating cows	2	2	2	2	3	2
Breed	Fresian cross	Fresian cross	Fresian cross	Fresian cross	Fresian cross	--
Total fresh milk produced (Liters/cow/day)	7,200	4,400	5,280	4,500	6,990	5,556
Average productivity (Liters/cow/day)	10.0	6.2	7.3	6.3	6.5	7
Value of milk produced (Liters/farm/year)	216,000	222,000	316,800	137,070	198,960	214,638
Main buyers of milk	Traders	Consumers	Consumers	Processor	Dairy coop	--
Average price of milk (Ksh/liter)	30.0	50.0	60.0	30.0	28.5	39.8

Source: Kenya Dairy Board, Egerton University 2016

Figure 2: Dairy cattle distribution and density across Kenya



4 Njarui et al. 2016; RoK 2015; Kibiego et al. 2015; Bebe et al. 2003; Mugambi et al. 2015 in Odero-Waitituh 2017

A smallholder dairy farmer in Kenya typically owns between one and five head of cattle—mainly Ayrshire, Friesian, Guernsey and Jersey crossbreds. Production systems are dependent on rain, and as a result, farmers face regular feed shortages during the dry season. In addition, limited land for cultivation also means some producers face year-round feed shortages. Feeds range from commercial concentrates to natural pasture, crop residues, green forages (e.g. weeds), leaves and pods, hay, salt, local brewery residue among other[5].

Feeding and management make up about 80% of the total costs for a successful dairy enterprise, with feeds constituting on average 68% of the total costs. However, fodder production is very low, except for Napier grass in the high altitude agroecological region of Kenya. There are several reasons for low forage production, namely:

- small land holdings
- lack of specialization in high potential farming areas in central Kenya and eastern provinces (notably Meru and Embu)
- limited research in commercial fodder-feeding dairy practices
- low extension support
- limited knowledge and practice among the younger generation

FAO and New Zealand Agricultural Greenhouse Gas Research Centre (2017) estimate that the intensive and semi-intensive production systems together produce 65% of the total emissions, which is 12.3 million tonnes CO2eq, from dairy production. Current emissions intensities range from 1.8–3.1 CO2eq per kg of milk (Brandt et al. 2018).

2.3 Dietary requirement for dairy cattle

The optimal dairy cattle feeding regime should consist of 75% energy sources, 24% protein sources and 1% mineral sources (Goopy and Gakige 2016 and Lukuyu et al. 2012). Most of the energy is derived from roughage and legumes and is available from most grasses including Napier (Elephant grass), Guatemala grass, giant setaria, Rhodes and Kiyuyu grass in the central, eastern and rift valley regions of Kenya. Energy is necessary for body maintenance, milk production, growth, weight gain and reproduction. Protein is necessary to break down the roughage into usable nutrients. Younger plants, particularly legumes (pasture and fodder), have a rich protein and vitamin content. Examples of protein sources are bean straw, sweet potato vines, Desmodium, lucern, omena, sunflower and white clover as well as fodder trees such as calliandra, leucaena, mulberry and sesbania. The optimal dairy feeding regime should consist of nutrients such as; water, energy, protein, fibre, vitamins and minerals.

5 SNV 2013

3. Business case modelling

3.1 Key assumptions and steps

The business model presented here is a basic cost–benefit analysis in which optimal herds of dairy cattle are determined for households with varied parcels of land (an acre of land or less, two to three and four to five). Land is assumed to be the major constraint to optimal herd size.

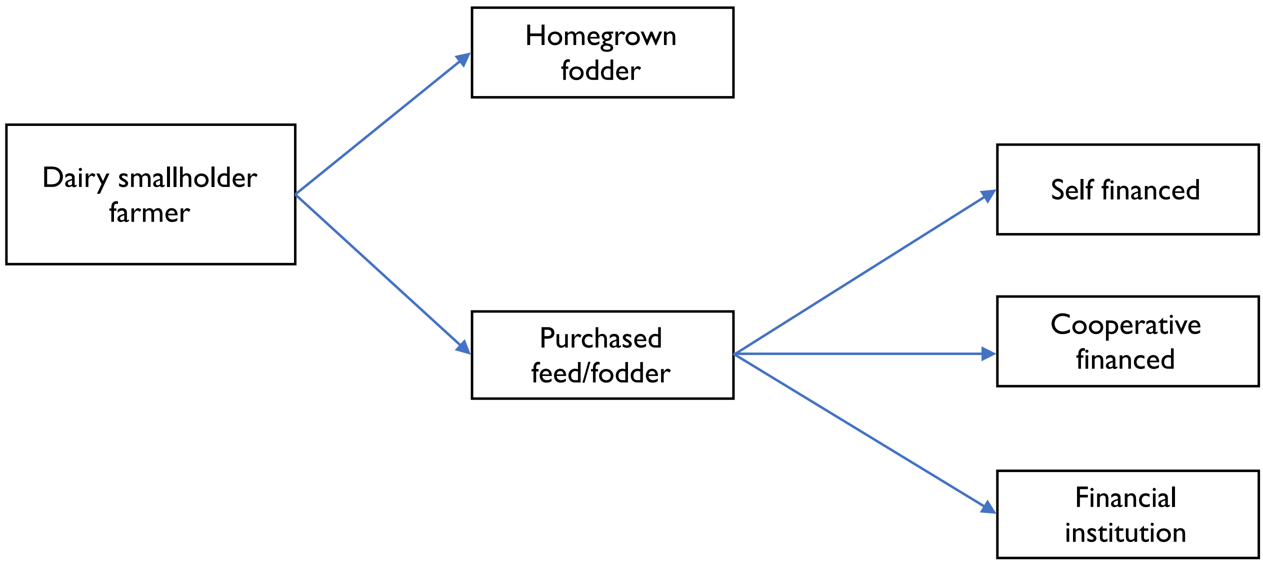
1. The steps used in the analysis are as follows:
2. The dairy production system, fodder variety and optimal herd size for different sized parcels under fodder farming is determined.
3. Data on farm operations from three counties is presented.
4. The feasibility analysis of fodder management is conducted for three counties where a project might be implemented.
5. The fodder project investment cost–benefit analysis at macro level is presented.
6. Overall, the public investment cost of implementing a program targeting up to 30,000 smallholder households over a five-year period is estimated.

Key assumptions are that households either buy or grow fodder for feeding of dairy cattle and milk prices remain within their current normal range and are not affected by the increased availability of fodder and/or increased production throughout the year. Farmers are assumed to sell some of their milk through formal channels e.g. through producer associations, hence this analysis is based on the quantity of milk marketed, and not the total quantity produced. The best-case and worst-case scenarios are presented for an intensive dairy production system—zero grazing. The best-case scenario differs from the worst-case scenario in terms of price, quantity of milk sales and the dynamics of feeding. Information on the gross margins at various levels of investment are used to indicate the anticipated financial benefits. The cost items used to guide the model in making production decisions are cost of quality concentrate feeds for supplementation, other input expenses such as labour, AI, and pests and disease control.

3.2 Fodder procurement options in the model

Purchased fodder from off farm sources is financed by household income/savings or loans. Credit facilities are extended to farmers by cooperatives or producer associations, or alternatively by formal financial institutions some of which use farm records as collateral.

Figure 3: Fodder procurement channels for dairy farming



3.3 Feasibility analysis of fodder management at a micro level

The core components guiding this analysis are:

i. How many cows can be supported sufficiently when the following portion of land is put under fodder cultivation per year for dairy feeding supplementation?

- 0.25 acres
- 0.5 acres
- 1 acre
- 2 acres
- 3 acres
- 4 acres
- 5 acres

ii. A cost–benefit analysis of fodder production for smallholder farmers at household level using data collected from five counties.

3.4 Optimal herd size for different land holdings

The main production system investigated by the study is zero grazing production system (intensive stall-feeding system) with one case study combining zero-grazing with paddocking. The main types of fodder cultivated by some of the households in the study are Napier, Rhodes grass and Desmodium. Table 2 presents the optimal herd size that can be sustained by a household that apportions various parcels of land (from 0.25 acres to five acres) to fodder production.

Table 2: Optimal herd size for various land area put under fodder production

Annual production per acre (bales)	Acres under fodder cultivation for dairy foliage/forage	Total production per annum for landing holding	Optimal herd size (number of cows)	Surplus/deficit fodder (bales)
1200	0.25	300	1	0
1200	0.5	600	1	235
1200	1	1200	3	0
1200	2	2400	6	0
1200	3	3600	9	0
1200	4	4800	13	0
1200	5	6000	16	0

Source: Calculation based on literature and scoping interviews

3.5 Farm level cost–revenue analysis for five counties

Introduction

Key informant interviews were conducted with purposively selected farmers from Kenya's central region (Murang'a, Kiambu, Nyandarua and Nyeri counties) and Rift Valley region (Uasin Gishu and Nakuru counties). The information is used to present basic cost–benefit analysis for one representative household from each of the five counties. The households own varying parcels of land and numbers of dairy cattle, sell varied quantities of milk and consume part of their production. All households are assumed to face varying market prices. Each household can produce varying quantities of milk, a portion of which is sold through dairy cooperatives or producer associations. Note that in many counties expanding fodder farming will reduce area available for food crops. For each county, three cases are presented. A base case (Case A) where the household derives income from current on-farm operations as is; a second case (Case B) where the household cultivates fodder, facing an opportunity cost of land; and a third case (Case C) where the household cultivates another crop instead of fodder. The cases are derived from the reality of the farmers interviewed in each county. For each case, two scenarios are evaluated—a best case with higher milk outputs and prices, then the worst case, in order to see how sensitive the farm revenues are to changes in output and price. We note that output–price fluctuations are the greatest risk smallholder farmers face. These prices can fluctuate by up to 30%, and so many farmers choose to diversify their farming activities. Since there are five counties, the total number of cases analysed is 15, each with two scenarios. The cases are presented in the following order: Murang'a county, Kiambu county, Nyandarua county, Nyeri county and Uasin Gishu county.

The counties

Murang'a county

Most households in Murang'a South, Murang'a county hold one to five acres of land. The average daily milk production per cow is seven litres. Feed comprises fodder supplemented by concentrates (dairy meal/maize jam). The typical cow diet consists of Napier grass and maize stalks (a by-product). There is plenty of potential for fodder crop expansion, with the representative household for this area having three acres of land, of which less than half an acre is currently allocated for Napier and local grass production. This type of household has the capacity to allocate between 0.5 and 2 acres of land under fodder production, even if it means foregoing the opportunity cost of producing food crops on this land. Case A assumes a household that purchases fodder with relatively poor land utilization and feeding regimen, rearing two Friesian cows (both milked); Case B is the same household, but they grow fodder over one acre, everything else remaining the same. In Case C, the household cultivates alternative crops whose monetary equivalence is reported.

Kiambu county

Land availability is lower in Kiambu than Murang'a county, with most households having less than two acres. Typical enterprises achieve relatively higher dairy productivity than in other counties (12 litres per cow per day). Most households in Kiambu county mainly use purchased fodder to supplement concentrates (dairy meal/maize jam). This fodder is mainly Napier, food crop residue and Desmodium in Githunguri area. The opportunity for fodder production in Kiambu county is limited. Case A is the base case practiced by most farmers in Kiambu, cultivating fodder on 0.5 acres for a herd of two cows, both milked under poor feeding regimen with best and worst cases differing on milk quantity and price (KES41 versus 38). Case B is an astute career farmer who has optimized his enterprise which purchases and grows fodder on 1.5 acres, rearing twelve Friesian cows (four milked) with the best and worst cases differing on milk sales (100 to 110 litres) and price (KES41 versus 38). Case C reports an enterprise which farms an alternative crop instead of fodder.

Nyandarua county

The typical land holding in Nyandarua county (Kinangop) is two to three acres with average daily milk production per cow of five litres. There are pockets with larger land parcels but whose primary economic activity is not dairy farming. The main fodder available in the county is Napier and maize stalks with limited land for expansion. Case A is a farmer who grows fodder on half an acre, feeding two Zebu cows with a poor regimen; one of the cows is milked. Case B is a farmer who grows fodder on 0.5 acres, with a herd of three Friesian cows, two of which are milked. The best-case and worst-case scenarios differ on milk yield/sales and erratic milk price (KES40 versus 30). Case C reports an enterprise which farms an alternative crop instead of fodder.

Nyeri county

Nyeri county has an average land holding of between one and three acres. The average daily milk production per cow is about six litres per day and most popular fodder is Napier. The case studies are based on Othaya sub-county. The county has sufficient land for expansion of fodder farming. Case A is about a representative household which grows fodder on 0.5 acres with two local breed cows, one of which is milked. Case B is a household which plants fodder on one acre with three dairy cows, all of which are milked. The best- versus worst-case scenarios differ on daily milk output. The milk price is maintained at KES35 per litre. Case C reports an enterprise which cultivates an alternative crop instead of fodder.

Uasin Gishu county

The typical land holding in Uasin Gishu county is four to seven acres (acquired under a scheme) with average daily milk production per cow being six litres. The main fodder crops are Napier and Poma Rhodes grass with sufficient land for expansion. Typical households in Uasin Gishu county feed their cows Napier and grass supplemented by commercial concentrates. Case A is a representative farmer who has a herd of four cows—all are milked—with five acres paddock for free range feeding on Rhodes grass. The difference between best- and worst-cases lies in daily milk output quantities and prices (KES35–39). Case B is a farmer who grows improved fodder on one acre (paddocking) practicing an improved feeding regimen for a herd of five Friesian dairy cows, only two of which are milked. Case C reports an enterprise which farms an alternative crop instead of fodder.

The model results: cost-revenue analysis by county

Murang'a county Land holding: 1–5 acres
Average daily milk production per cow: 7 litres
Feeding: fodder supplemented by concentrates (dairy meal/maize jam)
Fodder: Napier and maize stalks (after maize for consumption is plucked)
Room for fodder crop expansion: plenty
Implicit cost/trade-off: competition with food crops

Case A. "As is" current land use, purchasing fodder: two Friesian cows (*rates monthly equivalent)

Item	Particulars (*rates are monthly equivalent)	Best case KES	Best case %	Worst case KES	Worst case %
A. Revenues	Milk sales (24L best, 16L worst)	25200	93%	15840	90%
	Calf sale (2)*	1335	5%	1335	8%
	Manure*	500	2%	500	3%
	Total revenue	27035		17675	
B. Costs	Dairy meal—2 sacks (70kg)	2600	10%	2600	10%
	Salt lick	800	3%	800	3%
	Hay (KES250/bale *60 bales)	15000	60%	18000	72%
	Labour	6000	24%	6000	24%
	Water	500	2%	500	2%
	Pesticide*	50	0%	50	0%
	AI services*	125	0%	125	0%
	Total expenditure	25075		28075	
Gross margin (A–B)		1960		-10400	

Best price = KES35, worst price = KES33, best case hay costs KES250, worst case hay costs KES300

Case B. Growing fodder on one acre: two Friesian cows (*rates monthly equivalent)

Item	Particulars	Best case KES	Best case %	Worst case KES	Worst case %
A. Revenues	Milk sales (35L best, 20L worst)	37800	82%	19800	72%
	Calf sale (2)*	1667	4%	1667	6%
	Manure*	0	0%	0	0%
	Sale of hay (30 bales surplus)	6900	15%	6000	22%
	Total revenue	46367		27467	
B. Costs	Dairy meal—1.5 sacks (70kg)	3500	27%	2000	16%
	Salt lick	800	6%	800	6%
	Hay production/storage (70 bales)	1000	8%	1000	8%
	Labour	6000	47%	6000	47%
	Water	500	4%	500	4%
	Pesticide*	50	0%	50	0%
	AI services*	125	1%	125	1%
	Opportunity cost of one acre land	833	7%	833	7%
	Total expenditure	12808		11308	
Gross margin (A–B)		33558		16158	

Best price = KES35, worst price = KES33, best case sell hay at KES230, worst case sell hay at KES200

Case C. Growing another crop, purchasing fodder: two Friesian cows (*rates monthly equivalent)

Item	Particulars	Best case KES	Best case %	Worst case KES	Worst case %
A. Revenues	Milk sales (24L best, 16L worst)	25200		15840	
	Calf sale (2)*	1335		1335	
	Manure*	500		500	
	Sale of food/cash crop	24000		10000	
	Total revenue	47035		27675	
B. Costs	Dairy meal—2 sacks (70kg)	2600		2000	
	Salt lick	800		800	
	Hay (@ KES250/bale *60 bales)	15000		5000	
	Labour	6000		6000	
	Water	500		500	
	Pesticide*	50		50	
	AI services*	125		125	
	Land field costs (paddock management)	6000		6000	
	Total expenditure	31075		20475	
Gross margin (A–B)		15960		7200	

Summary of findings

If the household grows its own fodder (Case B) it will have a better profit margin than the other cases. If the household were to consider farming another crop (Case C), it would still be better off than running the enterprise as they have been doing so far (Case A).

Kiambu county
Land holding (mid 50% of HH): 1–2 acres
Average daily milk production per cow: 12 litres
Feeding: fodder supplemented by concentrates (dairy meal/maize jam)
Fodder: Napier, Desmodium
Implicit cost/trade-off: none
Room for fodder crop expansion: limited

Case A. "As is" current land use, purchasing fodder: herd – two cows, both milked

		Best case		Worst case	
Item	Particulars (*rates are monthly equivalent)	KES	%	KES	%
A. Revenues	Milk sales (15L best, 12L worst)	18450	89%	13680	66%
	Calf sale (1)*	1250	6%	833	4%
	Sale of Napier	417	2%	0	0%
	Manure* (1 pickup load 2x a year)	500	2%	0	0%
	Total revenue	20617		14513	
B. Costs	Dairy meal—2 sack (70kg) mid yield)	2600	36%	3900	54%
	Salt lick	800	11%	800	11%
	Fodder (semi stall-feeding)	2500	35%	2000	28%
	Water	1000	14%	1000	14%
	Pesticide*	50	1%	50	1%
	AI services*	250	3%	250	3%
	Total expenditure	7200		8000	
Gross margin (A–B)		13417		6513	

Best and worst cases differ on milk quantity, price (KES41 versus 38), fodder and dairy meal consumption

Case B. Growing fodder on 1.5 acres: 12 Friesian cows, four milked

		Best case		Worst case	
Item	Particulars (*rates are monthly equivalent)	KES	%	KES	%
A. Revenues	Milk sales (110L best, 100L worst)	135300	94%	114000	94%
	Calf sale (1)*	5000	3%	4167	3%
	Energy savings from Biogas	3000	2%	3000	2%
	Total revenue	143300		121167	
B. Costs	Dairy meal/maize jam—8 sacks (70kg)	0	0%	10400	15%
	Salt lick (40k)	6000	8%	6000	9%
	Fodder (grass/maize stalk)	10,000	13%	18000	27%
	Food/Brewery residue (Pineapple powder and 'machicha')	30000	38%	0	0%
	Labour	10000	13%	10000	15%
	Water	3000	4%	3000	4%
	Opportunity cost of 0.5 acre land	2500	3%	2500	4%
	AI services and incidentals*	18000	0%	18000	0%
	Total expenditure	79500		67900	
Gross margin (A–B)		63800		53267	

This is a unique case of an astute career farmer who has optimized his enterprise. Best and worst cases differ on milk sales and price (100L KES41 versus 38) and feed regime (fodder + brewery residue versus dairy meal).

Case C. Growing another crop, purchasing fodder: two cows, both milked

Item	Particulars	Best case KES	%	Worst case KES	%
A. Revenues	Milk sales (15L best, 12L worst)	18450		13680	
	Calf sale (1)	1250		833	
	Sale of food/cash crop	30000		18000	
	Total revenue	49700		32513	
B. Costs	Dairy meal—2 sacks (70kg)	2600		3900	
	Salt lick	800		800	
	Fodder (semi stall-feeding)	5000		4000	
	Water	1000		1000	
	Pesticide	50		50	
	AI services	250		125	
	Land field costs (paddock management)	10000		7000	
	Total expenditure	19700		16875	
Gross margin (A–B)		30000		15638	

Summary of findings

Again, the model suggests that households are better off growing their own fodder (Case B). This results in a higher profit than if households were to farm another crop for sale (Case C).

Nyandarua county
Land holding (mid 50% of HH): 2–3 acres
Average daily milk production per cow: 5 litres
Feeding: fodder supplemented by concentrates (dairy meal/maize jam)
Fodder: Napier
Room for fodder crop expansion: limited
Implicit cost/trade-off: competition with food crops

Case A. "As is" current land use, purchasing fodder: two Zebu cows, one milked

Item	Particulars (*rates are monthly equivalent)	Best case KES	%	Worst case KES	%
A. Revenues	Milk sales (6L best, 4L worst)	7200	73%	4200	43%
	Calf sale (1)*	2083	21%	667	7%
	Sale of Napier	417	4%	417	4%
	Manure*	167	2%	0	0%
	Total revenue	9867		5283	
B. Costs	Dairy meal—1 sack (70kg) (low yield)	1200	32%		0%
	Salt lick	800	21%	800	21%
	Fodder (Napier+maize stalk)	1000	26%	1000	26%
	Water	500	13%	500	13%
	Pesticide*	50	1%	50	1%
	AI services*	250	7%	250	7%
	Total expenditure	3800		2600	
Gross margin (A–B)		6067		2683	

*Best and Worst cases differ on milk quantity, price (@ KES41 versus 38), fodder and dairy meal consumption

Case B. Growing fodder on 0.5 acres: herd of three dairy cows: two milked, two calves

Item	Particulars (*rates are monthly equivalent)	Best-case scenario KES	%	Worst-case scenario KES	%
A. Revenues	Milk sales (15 L)	30000	69%	15750	36%
	Sale of calf/cow (2)*	13333	31%	13333	31%
	Manure*	0	0%	1000	2%
	Total revenue	43333		30083	
B. Costs	Dairy meal—4 sacks (70kg)	8000	40%	10000	50%
	Salt lick	2000	10%	2000	10%
	Fodder (Napier, maize stalks and sweetpotato vines)		0%	1000	5%
	Land lease to plant Napier (opportunity cost)	417	2%	0	0%
	Labour	9000	45%	9000	45%
	Pesticide*	83	0%	83	0%
	Deworming and incidentals	300	1%		0%
	AI services*	375	2%	375	2%
	Total expenditure	20175		22458	
Gross margin (A–B)		23158		7625	

*Best and worst cases differ on erratic milk price (KES40 versus 35)

Case C. Growing another crop, purchasing fodder

Item	Particulars (*rates are monthly equivalent)	Best case KES	%	Worst case KES	%
A. Revenues	Milk sales (6L best, 4L worst)	7200		4200	
	Calf sale (1)*	2083		667	
	Sale of Napier	417		417	
	Sale of food crop	20000		15000	
	Total revenue	29700		20284	
B. Costs	Dairy meal—1 sack (70kg) (low yield)	1200			
	Salt lick	800		800	
	Fodder	1000		1000	
	Water	500		500	
	Pesticide*	50		50	
	AI services*	250		250	
	Land field costs (paddock management)	8000		7000	
	Total expenditure	11800		9600	
Gross margin (A–B)		17900		10684	

Summary of findings

The same pattern repeats itself in Nyandarua county. Households are better off growing their own fodder (Case B) since profit margins are higher than farming another crop for sale (Case C) in the best-case scenario. However, in the worst-case scenario analysis, growing a marketable food crop yields higher profit than growing fodder.

Nyeri county
Land holding (mid 50% of HH): 1–3 acres
Average daily milk production @ cow: 6 litres
Feeding: fodder supplemented by concentrates (dairy meal/maize jam)
Fodder: Napier
Room for fodder crop expansion: available
Implicit cost/trade-off: competition with food crops

Case A. "As is" current land use, purchasing fodder: two local breed cows, one milked

Item	Particulars (*rates are monthly equivalent)	Best case KES	%	Worst case KES	%
A. Revenues	Milk sales (7L best, 4L worst)	6720	72%	4200	79%
	Calf sale (1)* (11 months matured)	2083	22%	667	13%
	Sale of Napier	417	4%	417	8%
	Manure*	167	2%	0	0%
	Total revenue	9387		5283	
B. Costs	Dairy meal—1 sack (70kg) (low yield)	1200	39%	0	0%
	Salt lick	800	26%	800	43%
	Fodder (2-month Jan–Feb per annum)	250	8%	250	14%
	Water	500	16%	500	27%
	Pesticide*	50	2%	50	3%
	AI services*	250	8%	250	14%
	Total expenditure	3050		1850	
Gross margin (A–B)		6337		3433	

Case B. Growing fodder on one acre: three dairy cows, all milked

Item	Particulars (*rates are monthly equivalent)	Best case KES	%	Worst case KES	%
A. Revenues	Milk sales (40L best, 36L worst)	42000	91%	37800	93%
	Calf sale (2)*	2500	5%	1250	3%
	Energy savings (biogas)	1500	3%	1500	4%
	Total revenue	42400		40550	
B. Costs	Dairy meal—2 sacks (70kg)	3600	16%	5400	23%
	Salt lick	800	4%	800	3%
	Fodder (2 months Jan–Feb per annum)	1000	5%	1250	5%
	Land lease for Napier/opportunity cost 0.5 acre	292	1%	292	1%
	Labour + Napier transport cost	14000	64%	14000	58%
	Water	500	2%	500	2%
	Pesticide*	50	0%	50	0%
	AI services*	1875	9%	1875	8%
	Total expenditure	22117		24167	
Gross margin (A–B)		23883		16383	

*Best and worst cases differ on daily milk output quantities, milk price is KES35

Case C. Growing another crop, purchasing fodder: two local breed cows, one milked

Item	Particulars (*rates are monthly equivalent)	Best case KES	%	Worst case KES	%
A. Revenues	Milk sales (7L best, 4L worst)	6720		4200	
	Calf sale (1)* (11 months matured)	2083		667	
	Sale of Napier	417		417	
	Sale of cash crop	24000		10000	
	Total revenue	9387		5284	
B. Costs	Dairy meal—1 sack (70kg) (low yield)	1200			
	Salt lick	800		800	
	Fodder (2 months Jan–Feb per annum)	1000		1000	
	Water	500		500	
	Pesticide*	50		50	
	AI services*	250		250	
	Land field costs (paddock management)	6000		6000	
	Total expenditure	11800		9600	
Gross margin (A–B)		21420		5684	

Summary of findings

In Nyeri county, growing one's own fodder (Case B) is almost as good as farming another crop for sale (Case C). The profit margins are KES23,883 versus KES21,420. However, both alternatives are better than utilizing the land parcels as households do currently (Case A).

Uasin Gishu county
Land holding (mid 50% of HH): 4–7 acres (scheme 5 acres)
Average daily milk production per cow: 6 litres
Feeding: fodder supplemented by concentrates (dairy meal/maize jam), residue from maize stalk and hay from wheat
Fodder type: Napier and Poma Rhodes grass
Room for fodder crop expansion: plenty
Implicit cost/trade-off: competition with food crops

Case A. "As is" current land use, purchasing fodder: five cows, 2 milked

		Best-case scenario		Worst-case scenario	
Item	Particulars	KES	%	KES	%
A. Revenues	Milk sales (15L best, 10L worst)	15750	54%	10500	36%
	Calf sale (3)*	2500	9%	2500	9%
	Manure*	500	2%	500	2%
	Total revenue	18750		13500	
B. Costs	Dairy meal/maize jam—2 sacks (70kg)	4600	35%	4600	35%
	Salt lick	800	6%	800	6%
	Hay (Napier, local grass, wheat straw)	2000	15%	1800	15%
	Labour	5000	38%	5000	38%
	Water	500	4%	500	4%
	Opportunity cost of 0.5 acre land	0	0%	0	0%
	Pesticide*	50	0%	50	0%
	AI services*	125	1%	125	1%
	Total expenditure	13075		12875	
Gross margin (A–B)		5675		625	

*Best and worst cases differ on daily milk output quantities, milk price is KES35Summary of findings

Case B. Fodder planted on 0.5 acres: herd of four dairy cows milked, five acres paddock free range Rhodes grass

		Best-case scenario		Worst-case scenario	
Item	Particulars	KES	%	KES	%
A. Revenues	Milk sales (32L best, 22L worst)	37440	88%	23760	83%
	Calf sale (2)*	5000	12%	5000	17%
	Total revenue	42440		28760	
B. Costs	Dairy meal—7 bags (70kg)	11200	55%	11200	57%
	Salt lick	800	4%	800	4%
	Labour	1000	5%	1000	5%
	Water	4500	22%	4500	23%
	Pest control*	500	2%	500	3%
	Opportunity cost of 0.5 acre land	800	4%	800	4%
	AI services*	417	2%	417	2%
	Deworming*	500	2%	500	3%
	Total expenditure	19217		18717	
Gross margin (A–B)		22223		9043	

Case C. Growing another crop, purchasing fodder

Item	Particulars	Best-case scenario KES	%	Worst-case scenario KES	%
A. Revenues	Milk sales (15L best, 10L worst)	15750		10500	
	Calf sale (3)*	2500		2500	
	Sale of food crop	15000		10000	
	Total revenue	33250		23000	
B. Costs	Dairy meal/maize jam—2 sacks (70kg)	4600		4600	
	Salt lick	800		800	
	Hay (Napier, local grass, wheat straw)	2000		1800	
	Water	500		500	
	Land field costs (paddock management)	5000		5000	
	Pesticide*	50		50	
	AI services*	125		125	
	Total expenditure	13075		12875	
Gross margin (A–B)		20175		10125	

Summary of findings

As in the case of Nyeri county, growing one's own fodder (Case B) is almost as good as farming another crop for sale (Case C) if one compares profit margins (KES22,223 versus KES20,175) under the best-case scenario. But under the worst-case scenario, growing a marketable food crop yields higher profit (KES10,125) than growing fodder (KES9,043).

3.6 Feasibility analysis of fodder management at a macro level

Summary of micro-level findings

The micro-level findings indicate that in both the Rift Valley and central highland regions, many farmers could gain additional revenue if they invested in more fodder production. To assess the costs and benefits at a national level, this section looks at the projected cross-county change in milk productivity and profitability if fodder were planted in all five counties.

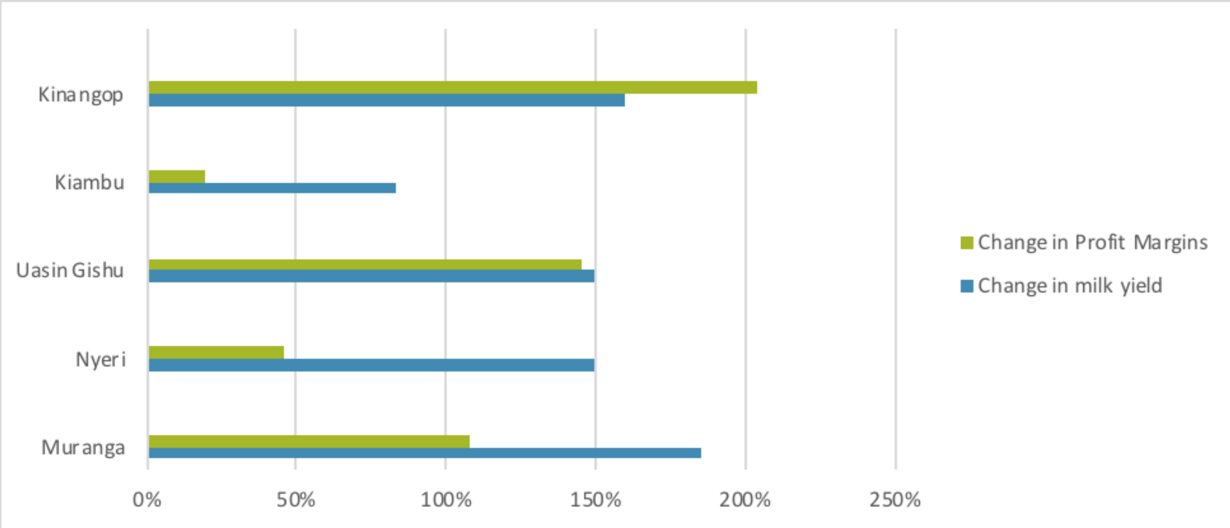
Assuming constant on-farm management parameters and that market prices do not change beyond the current range; fodder intensification can increase milk yield and profit margins for typical smallholder farming households. The best results come from Nyandarua, Murang'a and Uasin Gishu Counties, as shown in Table 3.

Table 3: Change in milk yield and monthly profit margin under fodder supplementation

County	Milk production per cow (kg/litres) with fodder		Change in daily milk yield	Profit margins with fodder intervention (KES)		Change in monthly profit margins
	Worst case	Best case		Worst case	Best case	
Murang'a	7	20	186%	16,158	33,558	108%
Nyeri	6	15	150%	16,383	23,883	46%
Uasin Gishu	6	15	150%	9,043	22,223	146%
Kiambu	12	22	83%	53,267	63,800	20%
Nyandarua	5	13	160%	7,625	23,158	204%
Average	7.2	17	146%	20,495	3,325	105%

The highest positive change in milk yield is expected from Murang'a and Nyandarua counties while the highest increase in profit margins are expected from Nyandarua and Uasin Gishu counties.

Figure 4: Percentage change in yield and monthly profit margins under fodder supplementation



Notes:

i. The overall result of analysis shows that smallholder farmers are better off farming fodder than utilizing their land to do something else (growing another crop or maintaining the current practice). Thus Table 4 is generated using data for the most optimal use of land through fodder farming.

ii. Change in profit margin is calculated using best-case and worst-case profit scenarios under fodder farming. This gross profit incorporates return from major marketable farm products and opportunity costs besides milk

iii. Values for change in milk yield are based on projections for output quantities associated with fodder

Fodder project investment cost–benefit analysis at macro level

From the foregoing analysis, adoption of the fodder farming intervention over a five-year project would have economic viability. Total monetary benefits (gross profit margins) exceed total monetary costs (financial investment outlay) by the second year of implementation (see Table 4 below). At project termination in year five, the total gross profit margins are USD21,402,683 against total costs of USD7,260,000. It is worth noting that, this analysis takes a rather optimistic view from a risk perspective which would bolster the case for fodder project intervention.

Table 4: Fodder project investment cost–benefit analysis (USD)

Fodder investment project cost						
Direct project implementation cost	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Financial obligation per partner[6]	220,000	220,000	220,000	220,000	220,000	1,100,000
Number of partners	3	3	3	3	3	
Total for all partners	660,000	660,000	660,000	660,000	660,000	3,300,000
Project administration cost (1.2*A)	792,000	792,000	792,000	792,000	792,000	3,960,000
Total Project Investment Cost (A+B)	1,452,000	1,452,000	1,452,000	1,452,000	1,452,000	7,260,000

6 Based on the assumption that implementation (outreach, extension among other services will be outsourced); similar costs were found in other USAID and donor programmes for outsourcing a one year project to an NGO firm etc.

Project investment project benefit (gross profit margin)						
County benefit per farmer						
Murang'a county	18158	22698	28372	35465	33558	138,252
Nyandarua county	7625	10751	15159	21375	23158	78,068
Uasin Gishu county	9043	11666	15049	19413	22223	77,395
Number of farmers adopting	3000	5000	7000	9000	10000	
Murang'a county	544,750	680,938	851,172	1,063,965	1,006,750	4,147,574
Nyandarua county	228,750	322,538	454,778	641,237	694,750	2,342,052
Uasin Gishu county	271,300	349,977	451,470	582,397	666,700	2,321,844
Total Project Benefit (Gross Profit)	984,800	2,130,753	3,881,897	6,511,233	7,894,000	21,402,683

Notes:

i. Direct project implementation and project administration costs will facilitate adoption of fodder farming.

ii. Farm level costs of fodder feeding intensification and production efficiency are borne by the farmer and have been taken care of in calculating the gross profit margins.

iii. Project administration costs are assumed to be 120% of direct implementation cost based on international multiplier rates.

iv. Profit margins have been worked out such that, they start from the lowest at year one (worst-case scenario of Table 4) and climb to the highest by year five (best-case scenario).

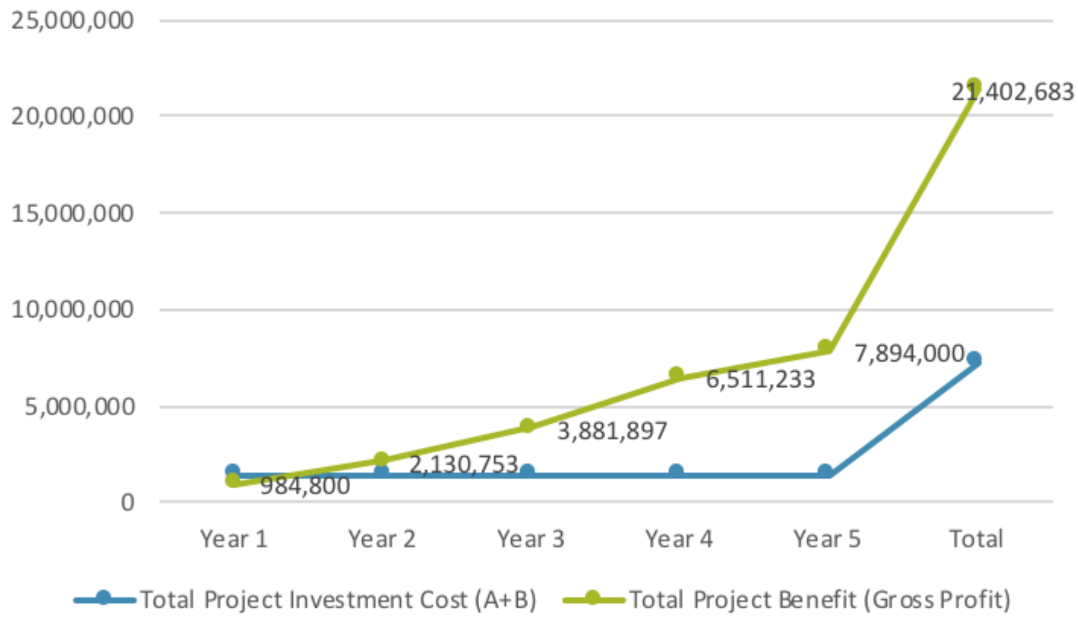
v. The adoption of fodder farming and intensification for already practicing households is estimated to start at 3,000 farmers per county by end of year one and culminate at 10,000 farmers per county by end of the project. The rate of adoption portends an increase of 2,000 farmers per year towards year four and decline to 1,000 farmers per year for year five.

Estimates of potential to reduce GHG emissions intensities through improving quality and quantity of feed range from 8 to 24% in intensive and semi-intensive dairy systems in Kenya (FAO and New Zealand Agricultural Greenhouse Gas Research Centre 2017), depending upon whether the fodder is supplemented with legumes, sweet potato silage or dairy concentrates. Taking a conservative approach to reflect low adoption rates, the same study found that feeding fodder legumes and fodder trees could result in 18 and 8% reductions respectively in enteric methane emissions from intensive systems. This could equal up to 0.46 metric tons of CO2eq. A newer and more spatially explicit analysis (Brandt et al. 2018) suggests that combining increased use of the most common improved forage—Napier grass—with dairy concentrates, could reduce emissions intensities in the Kenya dairy sector by 26 to 31%. Note that the impact of these estimates on total emissions depend on assumptions about levels of intensification and adoption, as well as number of animals.

Project estimated break-even period

It is estimated that the project will break even by the second year after initiation. Again, this is a strongly optimistic assumption of minimal risk, which if violated would result in extension of payback period by up to a couple of years. More robust estimations of project payback, rates of return among other parameters, can be carried out at project baseline survey stage before initiation.

Figure 5: Annual trends of total benefit versus total cost (USD)



4. Perspectives of other value chain actors

The analysis so far has focused on farmer level actions, costs and benefits. However, other value chain actors are also important to enable fodder production to be both viable and profitable. Indeed, the investment project outlined above assumes a budget for extension services (as explained below). Milk processors and representatives of dairy cooperatives were asked about what additional interventions could motivate greater adoption of improved fodder production by farmers. These two actors offer the best opportunities to reach farmers given that they provide access to markets (an incentive) and often offer services, particularly information, to their members. Five of the largest processers work with cooperatives and producer groups.

4.1 Dairy cooperatives and producer organizations

Dairy cooperatives dominate the marketing of milk in Kenya on behalf of their members who are mainly small-scale farmers. Kenya has thousands of dairy cooperatives and producer associations. Some of the most well-known cooperatives are Kinangop Dairy Ltd, Githunguri Dairy Farmers Cooperative Society (Fresha dairy products), Pascha Uplands Premium Dairies & Foods Ltd, Eldoville Dairy, Uplands Premium Dairies, Meru Central, Mukurwe-ini Dairy, Kiambaa Dairy, Kereita Dairy, Ndumberi Dairy, Othaya Dairy, Tetu Dairy, Sotik Dairy Farmers and Tarakwo Dairies. The key driver of membership to cooperatives is the opportunity to produce, market and have access to a platform where members can mobilize savings and benefit from economies of scale.

Cooperatives serve these farmers by collecting milk from them, bulking it and then distributing it as raw or pasteurized to various places; or as dairy products such as yoghurt, ghee, butter and cheese. Cooperatives have the potential to improve productivity in the smallholder sector and enhance market participation by farmers. In addition to this service, they assist farmers to acquire credit facilities, farm inputs and AI services at relatively low costs. Cooperatives can help smallholder farmers to overcome various constraints such as access to financial resources which limit their chances of increasing scale of production due to high transaction costs. Cooperatives also have the potential to improve farmer productivity in the dairy sector as well as enhance market participation by farmers.

In terms of specific incentives that could increase adoption of improved fodder production, improved markets (access, input and output prices) was a strong recommendation. Reliable markets (guaranteed market demand, market access and reliable transport infrastructure) are major determinants of the resources a smallholder farmer will devote to dairy farming. Virtually all dairy cooperatives, producer associations and farmers' groups exist to source markets for their members' milk. Therefore, improved markets were seen as likely to motivate farmers to invest in improved fodder.

Some member cooperatives have tried to facilitate dairy smallholder farmers to access quality inputs such as certified seeds and seedlings for improved fodder. Others have gone beyond encouraging members to farm improved fodder. Githunguri Dairy is one example of a cooperative that is buying hay in bulk (under contractual arrangement) to sell to its members at a subsidized rate.

On output prices, guaranteed stable returns act as an incentive for farmers to invest in new innovations that improve yields. One such innovation is improved fodder whose uptake can rise with training and support. The challenge with this innovation has been the regular fluctuation of output prices, sometimes by as much as 30%. The risk this poses to smallholder farmers pushes them away from intensification towards diversified economic activities. At present, there is no agency willing to bear the price fluctuation risk. Cooperatives are unable to do so as many are small and do not have sufficient reserves. Even larger cooperatives that are involved in processing like Githunguri Dairy, are not prepared or able to deal with this issue. As a result, farmers are reluctant to adopt new innovations unless there is a clear demonstration effect.

The other incentive viewed favourably was provision of information. Although many of the cooperatives have extension officers, their presence is limited. Information about the value and profitability of improved fodder production would be welcomed, as would basic information on techniques and other farmers' experiences.

4.2 Large milk processors

The two big processors in the dairy industry are New Kenya Cooperative Creameries a state corporation that was the dominant processor until 1992 when the market was deregulated, and Brookside Dairy, that ventured as the first private company in 1993 and that has grown to be the market leader.

In terms of incentives, one role the processors could play is to stabilize the market output price but this has not yet been possible. Currently, they can guarantee a minimum price although the control of the market by the three largest processors significantly limits the bargaining power of farmers or cooperatives (Makoni et al. 2013). Large processors can also assist with information dissemination and training.

We asked both groups about regulation or standards, but neither had any specific suggestions. Given the high level of informal marketing, it is not likely that standards would have much impact (USAID and Climate Focus 2018).

5. Project implementation

This section outlines a specific project that aims to increase fodder production and utilization in three counties, namely: Murang'a, Nyandarua and Uasin Gishu.

The project's title is "Enhancing dairy productivity through planting fodder". The plan is to target 10,000 farmers in each of the three counties with the aim of increasing fodder production and milk output per cow. The goal is to reduce methane emissions per unit of milk output per cow. Note that this feasibility analysis does not constitute a project baseline study.

5.1 Proposed intervention

The key points of the proposed intervention are given below.

Project name:	Enhancing dairy productivity through planting fodder
Target counties:	Murang'a, Nyandarua and Uasin Gishu
Target households:	10,000 in each county
Target outcome:	50% increase in milk output per cow, 100% increase in fodder production, smooth year-round supply of fodder
Effect:	Reduced emissions per unit of output per cow
Key constraints:	Convincing households to farm fodder, perception of household food insecurity among smallholder farmers
Needed:	Direct implementation and project administration logistics, training and extension, partnerships, plots for model farms

5.2 Implementation budget—sub contracts to implementing partners

The following cost estimates for the project have been developed by comparison with other similar development projects at a global level and USAID sponsored projects in Kenya.

Activity name	Activity description	Target	Duration	Budget (USD)	County names
Enhancing dairy productivity through planting fodder	Assisting 30,000 farmers in Murang'a, Nyandarua and Uasin Gishu counties to increase milk output per cow by 50%, fodder production by 100% and ensuring a smooth year-round fodder supply by:	30,000 farmers in five years (10,000 in each county)	2018–2023	1,100,000 (220,000 per annum X 5 years)	Murang'a county
			2018–2023	1,100,000 (220,000 per annum X 5 years)	Nyandarua county
	training farmers on how to optimize yield through better land utilization. providing technical assistance and business skills. Giving demonstrations through model farms. providing extension services.		2018–2023	1,100,000 (220,000 per annum X 5 years)	Nyandarua county
Total direct implementation budget (five years)				USD3,300,00	
Total direct implementation budget (year one)				USD660,000	

Note: Each county has one implementing partner

5.3 Project administration – year one

The project administration budget for year one of the project is described below.

Key activities	Purpose	Budget (USD)
Office setup and recruitment	To acquire a physical office location and to buy equipment	100,000
Baseline survey	To determine the baseline status of dairy enterprises, on-farm practices and performance (milk yield, prices, service providers and fodder storage capacity)	30,000
Establishing partnerships and market development	To identify sub-contractors in the target countries and initiate the necessary interventions along the dairy value chain to encourage fodder intensification	30,000
Training and extension	To conduct training-of-trainers and training of service providers, identify demonstration plots and lead farmers (50 per county), organize farmer exchange visits/tours	100,000
Labour (salary, wages and allowances)		300,000
Travel		10,000
Supplies		20,000
Other direct costs		50,000
Subcontracts		Budgeted
Indirect costs		30,000
Incidentals		122,000
Total administration budget – year one		792,000

5.4 Budget notes and assumptions

Labour (salary, wages and allowances)	Salaries for different years/quarters will vary depending on additional staff hiring. Allowances will remain constant over project period.
Travel	Travel expenses will increase slightly over the second year but will remain constant over the next periods.
Supplies	Spending on supplies will remain constant over project period.
Other direct costs	Spending on other direct costs will also remain constant.
Subcontracts	Subcontract expenditures will remain fixed although the number of target farmers will increase between year two and year four.

6. Conclusion

Based on the evidence presented, improving smallholder farmer access to improved fodder could contribute to improved productivity, income and reduced emissions in key counties where dairy production is prevalent. The business case model found that under every best-case scenario, farm profits would increase— in some cases quite dramatically— if farmers produced their own fodder. This was also true in three of the worst-case scenarios. This assumes that farmers would switch land use from crops to fodder. The emissions intensity reductions would also be significant (up to 30%).

The main risk farmers face is fluctuating milk prices, which has been well documented elsewhere (e.g. Makoni et al. 2013). In addition, farmers currently lack information on fodder production, access to seeds, proper storage and silage techniques. Finally, fodder markets are only weakly developed and very few farmers have experience with commercial fodder production. Cooperatives and milk processors can provide a range of support—for example with extension support and bulk purchase/ supply—but very few currently do. Hence, there would be a solid rationale for an investment in a project specifically to improve fodder production.

The public investment cost of implementing a programme targeting up to 30,000 smallholder households over a five-year period is estimated at USD3.3 million (this excludes the individual farmer investment in improved feeding inputs). This investment can be justified as it is estimated that within a three-year period it would be paid back through higher productivity and income for the targeted beneficiaries.

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