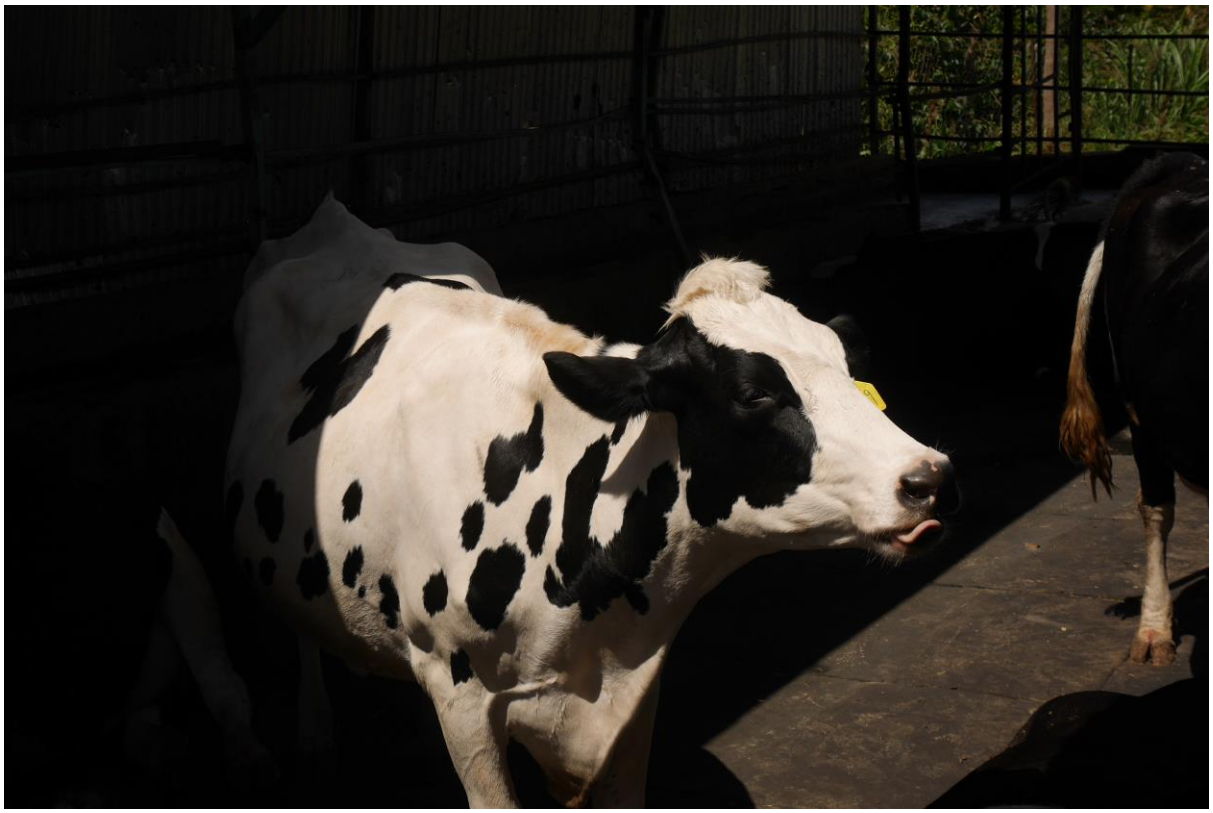
A Profitable Livelihood Activity?
Perspectives of Smallholder Dairy Producers in Kibugu, Kenya.



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Abstract

Kenyan smallholder farmers are highly dependant on the agricultural sector to provide economic stability and household security for a majority of rural dwellers. Scholars have highlighted the potentials of livestock as a pathway out of poverty and emphasises the importance of this sector for the development in Kenya (International Livestock Research Institute, 2011). This study aims to assess the viability of dairy production for farmers in Kibugu location, Embu County. The research was based on a 10 day field work and where various quantitative and qualitative methods were applied. The empirical data was analysed using the Sustainable Livelihood Framework (Scoones, 2015) to ascertain the farmers' decision-making processes and understand what factors are shaping their farming practices. In addition to this framework, a cost-benefit analysis has been completed to determine the profitability of their dairy activity. Farmers in Kibugu are mainly keeping livestock for subsistence purposes and are selling the surplus through various milk channels. Keeping livestock implies several challenges especially regarding farmers relations to the market structure. While the cost benefit analysis determined that the profitability of dairy farming is low, it still presents a viable livelihood strategy for smallholders within their crop-dairy systems.

Acknowledgements

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List of Acronyms

AI - Artificial Insemination

CBO - Community Based Organisation

KCC - Kenya Cooperative Creameries

KSh - Kenyan shilling

SLF - Sustainable Livelihood Framework

SSI - Semi-structured interview

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Introduction

The development of the milk market can be analysed worldwide through time. Population growth used to drive the global milk demand but, nowadays, the rising demand is explained by the per capita milk consumption in developing countries. Milk sales have been marked by the global deficit of milk production since 2004 which has eventually induced the increase of prices. The FAO (2010) concludes in a report that this is partly due to the fact that small changes in the milk availability greatly impact the world market. Prices are also influenced by feeds prices, itself impacted by land prices and climate events (e.g. droughts). The International Farm Comparison Network (IFCN) estimated that 12-14% of the world population live within dairy farming households with a mean dairy herd size of around two cows that give an average milk yield of 11 litres per farm per day (FAO, 2010). It is also clear that livestock reduces poverty and enhance food security in particularly fragile areas where it is important to self-produce a source of nutrient. Moreover, small-scale milk production creates many employment opportunities throughout the dairy chain (e.g. processors and intermediaries).

Kenya greatly depends on agriculture to improve livelihoods of smallholders in rural areas as it is estimated that 80% of Kenyans use agriculture to sustain their household (Muriuki et al., 2001). Smallholders crop-dairy systems are dominant in the milk production in Kenya, livestock adding value to both dairy and crop production. Indeed, livestock represent several opportunities, from the sales to self-subsistence, and ensure a stable financial environment for the household. Additionally, the production of manure to support crops, the role of cattle as insurance against life hazards, and the social status of having cattle are reasons why this activity is important to Kenyans. Dairy is the largest livestock sector in Kenya and provides to Kenyans one of the highest milk availabilities per capita in Sub-Saharan Africa (Muriuki et al., 2001).

The dairy sector in Kenya

Dairy production has great importance to the Kenyan livestock sector. Looking at the national level, the dairy sector accounts for 30% of the livestock GDP (FAO, 2011). Through history, the dairy industry has been influenced by shifting political environments, and, focusing on the colonial and postcolonial era, these changes can be subdivided into four phases of policy development for dairy production (FAO, 2011).

Before independence, the dairy market was concentrated around large-scale settler farmers and the possibilities for export. The British policy makers attempted to introduce improved dairy cattle to the production in forms of new breeds of cattle and artificial insemination (AI), but, at the time, these initiatives were confined to the European farmers in Kenya (Conelly, 1998). When Kenya gained its independence in 1963, things started to change, and during the first presidential administration there was a shift towards a smallholder-oriented type of production where the Kenyan farmers were given more opportunities. The government mandated that the Kenya Cooperative Creameries (KCC) should accept all milk despite of its heritage and they introduced a uniform pricing system. This gave room for farmers to secure their share of production through a stable market (Kijima, 2009). Furthermore, it also gave smallholders the possibility to invest in improved cattle and AI. However, the period of the second administration from 1979-2002 was characterised by corruption and economic instability and this reflected in the dairy industry. The KCC became bankrupt, which resulted in a liberalisation of the formal milk market in 1992 and private traders and private processing companies emerged on the market (ibid.). The uncertainty of the formal market led to a rapid growth in the informal sector which is where most of the dairy production figures today (FAO, 2011: Odero-Waitituh, 2017).

Today, the production of dairy is dominated by smallholder dairy farmers, and the structure of the market is made up from various actors in the field (FAO, 2011). More private cooperatives have entered the market and are offering livestock services such as AI (FAO, 2011). Along with trends of population growth and an increased demand for exports and more produce, Odero-Waitituh (2017) describes the potential for an intensification in the dairy market.

This paper continues to build on the body of literature which highlights the low milk productivity of cows in rural Kenya, the high potential for increasing productivity, and effecting meaningful change to rural livelihoods. It is estimated that about 80% of the dairy cattle in Kenya are reared and maintained on smallholdings where typically 1 to 4 cows are kept on relatively small parcels of land between 1 and 2 acres (Omore et al., 1998; Muriuki et al., 2001). A majority of these activities are practiced in the fertile central highlands with about 60% of total milk production coming from just 10% of Kenya's total landmass (Omore et al., 1998). Over 95% of smallholders in the kenyan highlands use livestock manure to fertilise their crops. Manure continues to be highly valued as farmers realise the long-term residual benefits to the soil and costs of inorganic fertilisers increase (Lekasi et al., 2001).

However knowledge is lacking for proper management practices of this resource and as such can lead to inefficient nutrient flows (Omore et al., 1999).

The research of Omore et al. (1998) found that the central districts is where 80% of the exotic, crossbred and high-performance dairy cows are found. The work of Bebe et al. (2003) confirms this finding while also highlighting the tendency for farmers to keep large mature size dairy cows, such as Friesian and Ayrshire, as a component of their intensification strategies.

The management of farming systems can vary greatly from mechanised and intensive production schemes to low input low output subsistence farming. Production of milk is heavily influenced by the availability and quality of feed. Most systems consist of stall feeding or zero-grazing practices, requiring farmers to supplement all of the nutritional needs of the cow through feeds and cut and carry fodder. As population increases, the access and availability of feed resources becomes scarcer, highlighting a severe constraint that farmers face, especially in the dry season. This factor continues to be the major cause of low milk yields and poor reproductive performance in the region (Omore et al., 1999; Bebe et al., 2003).

A common acknowledgment in the literature is the key role that adoption of dairy production has had on improving rural livelihoods. Therefore, in the context of smallholder dairy producers in Kibugu, we aim to assess the interactions between cost and benefits and livelihood strategies, which marks a distortion in our common beliefs of profitability.

Research Objective

Overall objective:

An assessment of dairy farming as a viable livelihood strategy for farmers in Kibugu.

Specific objectives (expanded in Appendix 1):

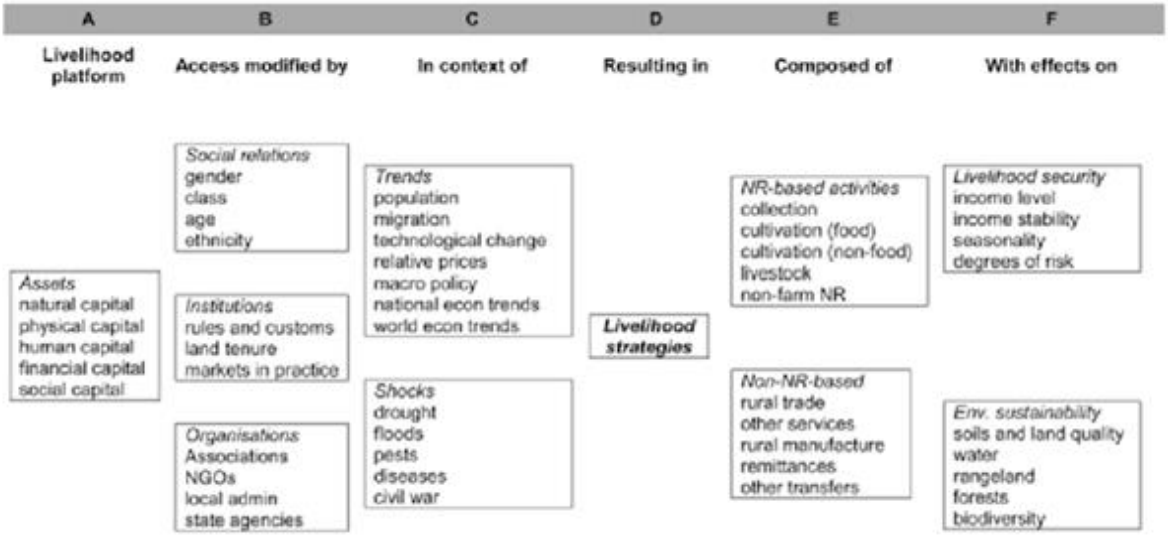
- To determine characteristics influencing the dairy production
- To assess the farmers' production profiles
- To characterise the structure of the dairy production
- To assess the value of dairy production
- To characterise the structure of milk marketing

Conceptual Framework

Sustainable Livelihood Framework

The research objectives will form the foundation for a discussion of viability of dairy farming in Kibugu. Through the Sustainable Livelihood Framework (SLF), we get an understanding of how different elements are contributing to farmers' decision-making processes and how these elements are related to each other (Scoones, 2015). The framework is based on an assessment of various elements that cover individual assets, contextual factors, institutional and organisational processes, livelihood strategies and livelihood outcomes (Figure 1).

Figure 1: The Sustainable Livelihood Framework



Source: Ellis (2000)

The assets refer to five different capitals that describe both material and social resources (Scoones, 1998; Ellis, 2000):

- Natural capital: The natural resource stocks such as soil and water, and the environmental services available.
- Financial capital: The capital base which determine the mobility towards any livelihood strategy.
- Physical capital: The equipment farmers possess such as milking tools, milk cooler, vehicles and storage space.

- Human capital: The knowledge, skills, health condition and working ability important in the pursuit of different livelihood strategies.
- Social capital: The social resources that people rely on in the pursuit of different livelihood strategies.

These capitals are modified by institutional and organisational factors that are shaped in a given context. The institutions are defined as "the rules of the game" and represent the structured patterns of behaviour, while organisations are related to "the players" and the processual reasoning behind these structures (Scoones, 1998). Both institutions and organisations are dynamic in the sense that they are ever changing and affected by each other and contextual factors. In our area of study, historical events, the political environment and socio-economic circumstances are all contextual factors that enable or constrain farmers' possibilities for action.

Different combinations of these inputs shape the pursuit of various livelihood strategies which will eventually result in livelihood outcomes (Scoones, 2015). In our assessment of the farmers' livelihood strategies, we have characterised the production systems in the area of study based on parameters such as herd size, farm size, breeding management, grazing management, milk offtake, on-farm consumption of milk, and marketed milk production. This way, we give a detailed assessment of how production systems characterise certain livelihood strategies. As part of the livelihood outcomes, a cost benefit analysis is applied to capture the monetary value of dairy farmers production practices. The analysis attaches tangible values to the livelihood outcomes of farmers, and, by ascertaining a monetary foundation of such activities, it provides a basis for analysis on the profitability of dairy production in Kibugu.

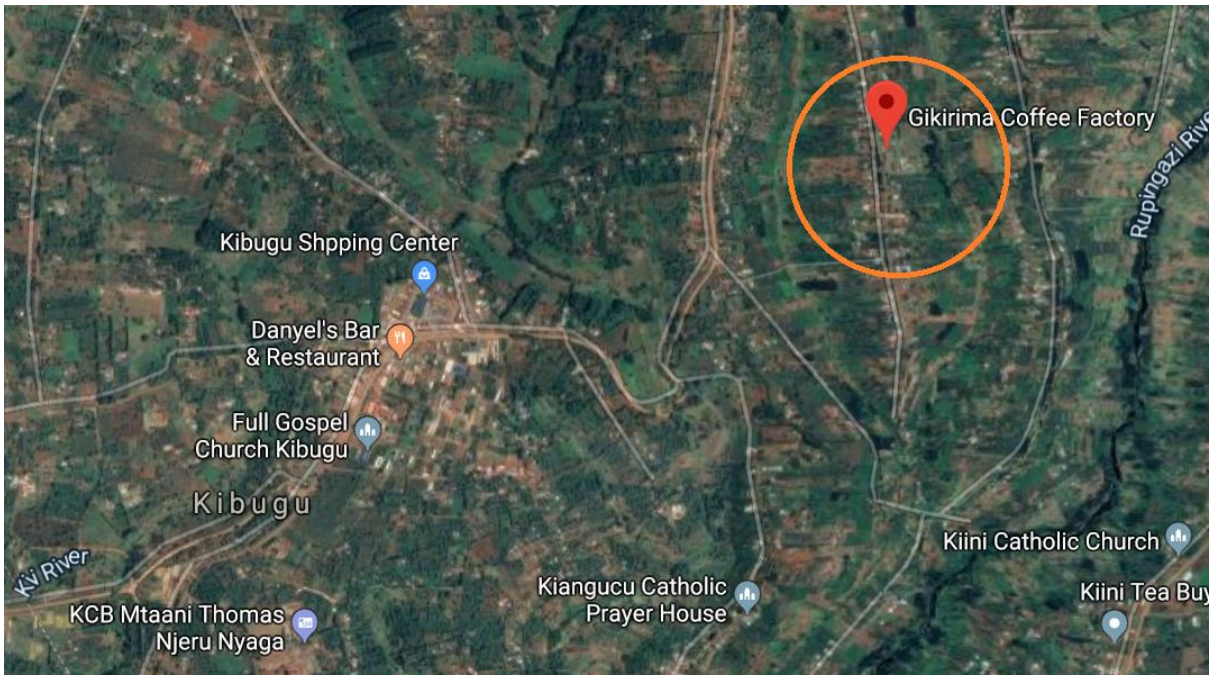
With this framework, we aim to outline the reasoning behind livelihood practices of the dairy farmers and discuss how the pursued strategies makes sense in a bigger picture of development, intensification, and profitability.

Description of Study Area

Our research was conducted in villages of Kibugu location, Embu County. Kibugu is located in the Central Highlands of Kenya, a three hour drive east of Nairobi. It is bordering the Mount Kenya Forest to the north and the landscape varies in altitude around 1600 m.a.s.l.. We were hosted in Gikirima sub-location, which is located a 10 minute drive west of Kibugu

city centre, and did most of our data collection in this area and the neighbouring sub-locations.

Figure 2: Study area (circle indicates our hosting location, Gikirima)



Source: Google Maps

70% of the population in Embu county earn their livelihoods from crop production and keeping livestock, thus the agricultural sector is of great importance to the whole county in terms of food security and economic stability (Ministry of Agriculture, 2016).

The climate conditions in the county is characterised by two rainy seasons through the year, one between March and June and one between October and December. Temperatures are ranging between 12°C and 30°C, depending on the season and the altitudinal position (Embu County, 2014). The seasonal patterns became an important part of our study as farmers' dairy production proved to be directly affected by changing weather conditions.

Methodology

All data was collected during 10 days of field work in Kibugu location. Throughout our field work, we applied both quantitative and qualitative methods in order to go in depth with our research questions. Coming from different academic backgrounds we could all contribute with our individual experiences and formulate a research design that could capture all the different aspects of interests.

Mapping

Throughout the field work, we used a Garmin handheld GPS to map the localities of our different encounters and create a visual representation on Kibugu location. It was both used to map our transect walk, to map the households responding to our questionnaires, and to map the location of our semi-structured interviews.

As part of the mapping, we did a transect walk with our local guides on the second day of field work. The purpose of this walk was to get familiar with the villages in the area and point out places of interest for further research. On our way, we located households keeping cattle and mapped different waypoints. This was very helpful in the following days when deciding where to hand out questionnaires as we had quite a broad overview of the area.

Figure 3: Transect walk

Source: Garmin GPS and Google Earth

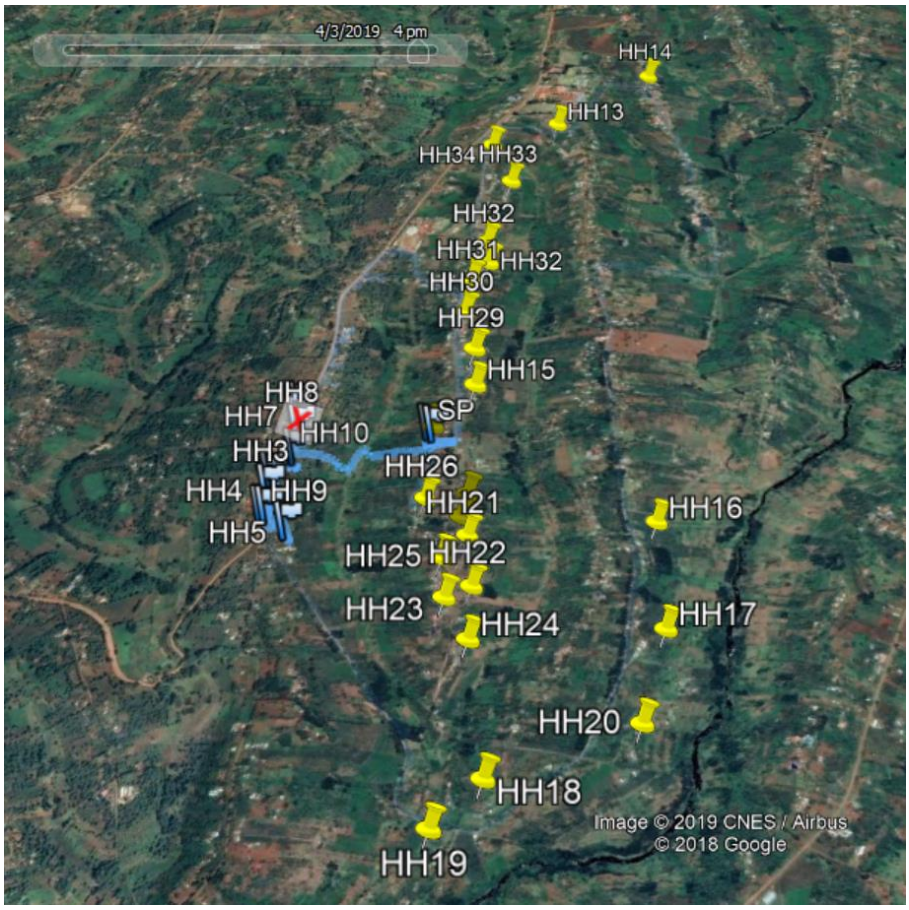
Questionnaires

We elaborated questionnaires to cumulate quantitative information to settle our starting point (see appendix 3). Through the questionnaires, we sought to get a better understanding of farmers' production capacities. This was done by defining basic information like the farm size, herd size and feeding systems. Moreover, the questionnaires were used to explain the marketing strategy of the farmers and determine what choice they make with the milk they

produce and which type of market (formal or informal) they choose to sell to. The incomes and expenses were also an important part of the questionnaires as they set the basis of the cost-benefit analysis.

We tested our questionnaire on three local farmers before taking it to the field. Over two days, we split into three groups conducting the questionnaires in different sub-locations. This way, we made sure to cover various locations in the area and diversify our selection of respondents. By questioning every 3rd household on our respective routes, we followed the guidelines for systematic random sampling (Bernard, 2011), and ended up having 33 respondents answering the questionnaires. The questionnaires have been essential in outlining the different factors of the dairy production in Kibugu.

Figure 4: Map of households questioned. HH means Household and SP means Starting point.



Source: Garmin GPS and Google Earth

Photo 1: Filling out questionnaires

Participant observation

Through participant observation, we seeked to get a better understanding of how the lives of the dairy farmers unfolded (Brockington and Sullivan, 2003). We took part in the everyday conversations and activities of people in the village, observing their daily routines and building a reciprocal relation (Spradley, 1980). By following the farmers' ordinary ways of managing their milk production, we gained insight into the physical setting of the production as well as the social dynamics revolving this labour. Given the short time span of the field work, participant observation provided a good way to quickly build a network and get in contact with informants.

Interviews

During the first days of fieldwork we engaged in informal interviews along with the participant observation. This was made up of conversations on the road, in the farms and with our host families, and through these informal interviews we obtained a better grip of what was important on the local level of milk production (Bernard, 2011). As our network became bigger, we were able to approach people we thought could be relevant to talk to in semi-structured interviews (Casley and Kumar, 1988). Our aim was to have a wide variety of people expanding on the different aspects of dairy production and marketing, and, therefore,

we both interviewed farmers who practiced dairy farming, officials from the county government, and the chairman and an employee from the local community-based organisation, Kibugu CBO.

In the first days of the field work, we prepared question guides for the interviews together with our Kenyan counterparts in order to make our semi-structured interviews uniform (see appendix 4). This way, the group members could carry out interviews separately and still be able to maintain a common reference frame for comparing and discussing the given answers (Bernard, 2011). The interview guides were reviewed through the field work so that we made sure to incorporate new topics or points of interest discovered along the way. We ended up doing 8 semi-structured interviews, two of them being group interviews with the agricultural officer and the livestock officer and with the chairman and employee from the local CBO. Most of the interviews we conducted in English, but, when in need, our guides or KEnyan counterparts helped us with the translation. By doing this type of interviews, we got a much more detailed picture of the individual farmer's background and practices related to dairy production as well as the structure of the local milk market. Furthermore, we got a deeper understanding of the different assets that make up the farmers' livelihoods.

Photo 2: Interviewing a farmer

Results and analysis

Sustainable Livelihood Framework

We have chosen to use the SFL as a basis to capture and analyse the data collected in the field. Based on data generated from the questionnaires, semi-structured interviews, and participant observation, we will outline the framework for a "typical" farmer from Kibugu location. The data collected was uniform in terms of fundamental factors such as housing, size of land, and purpose of dairy farming, and, therefore, we have decided to treat the farmers as an entity within this framework. However, the framework will also highlight that there are variations among the farmers production profiles that play a part in the formation of livelihood strategies and outcomes.

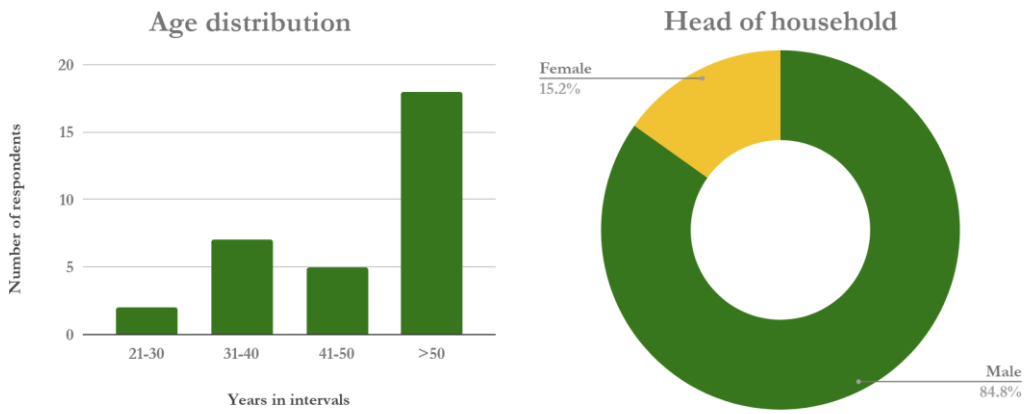
Assets

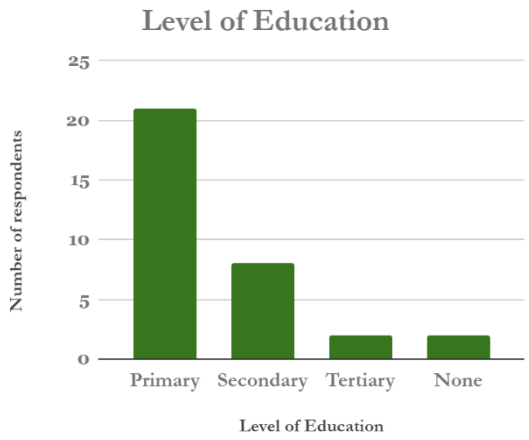
The assets described below are a foundational part of the framework as they indicate the farmers' capabilities to act and pursue certain livelihoods. In ascertaining these assets, we have looked at the answers given to the questionnaires, talked to farmers and key actors in the local dairy industry and observed how different dynamics played out in the field.

Human capital

In order to characterise the typical farmer, we have calculated the means of different parameters related to human capital. The figure below shows the distribution of responses related to these parameters:

Figure 5: Household information





Members of Household

Mean	Median	Min.	Max.
3,76	4	1	8

Source: Questionnaires

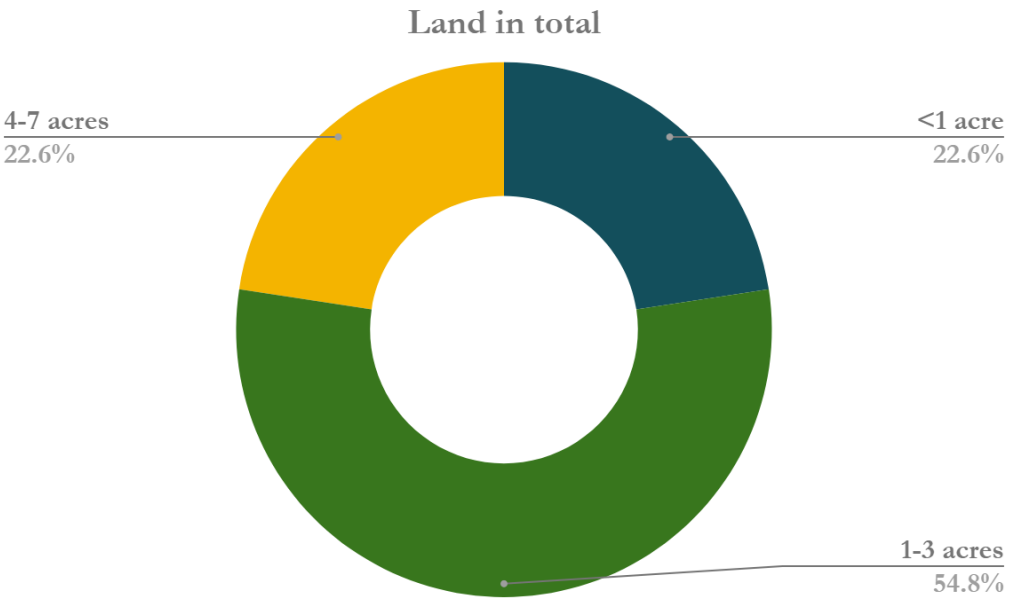
As indicated, the typical household would consist of four members with a male as head of the household. Despite this fact, 60,6% of the respondents were women of the households, and they would often be the ones carrying out the labour tasks related to dairy farming and would therefore have more detailed knowledge about the practice (questionnaires, observations). Since only a few farmers (14,71%) employed people to work on the farm, the on-farm workforce was mainly made up from the older generation of parents or grandparents.

As shown above, a majority of the respondents (61,76%) only completed primary level of education which could be a limiting factor for expanding their knowledge on dairy farming, but, as this practice has a long tradition, we would often hear that the knowledge was passed on from generation to generation and from farm to farm (SSI 1, SSI 7). The few farmers we met who had taken a longer education where typically also more engaged in the market structures revolving the practice and had established structures to intensify their production - either regarding their dairy or cash crop production (SSI 6, SSI 7).

Natural capital

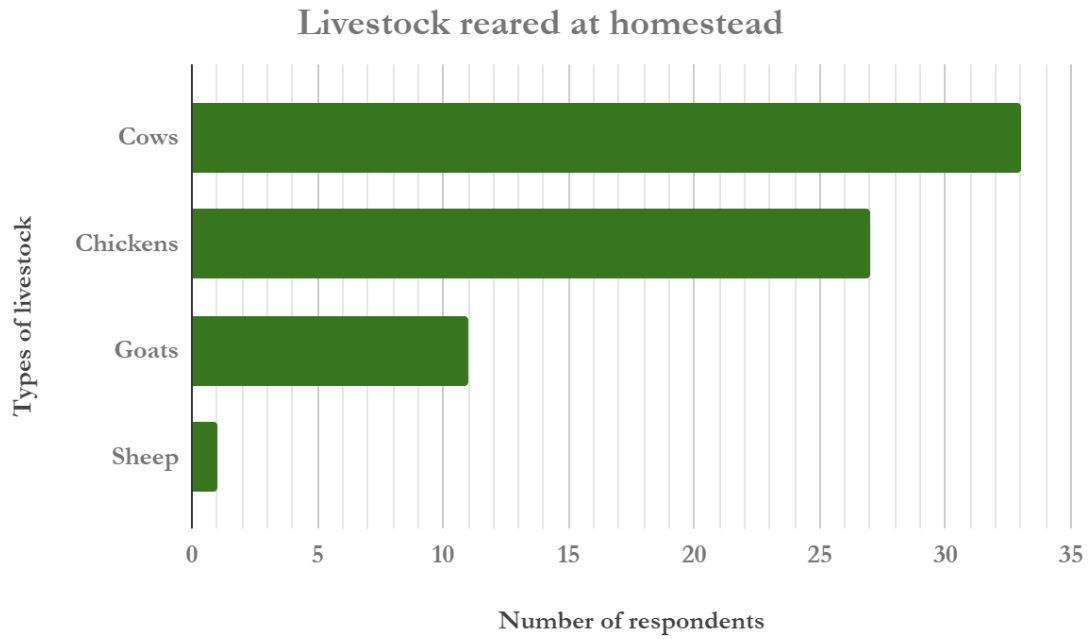
On average, a farmer would have between 1-3 acres of land to unfold their farming practices. Each household would have a variety of livestock confined to a small part of their land and the rest of the land would be used for cultivation of different cash crops (see Figure 6 and 7).

Figure 6: Total land



Source: Questionnaires

Figure 7: Livestock reared at homestead

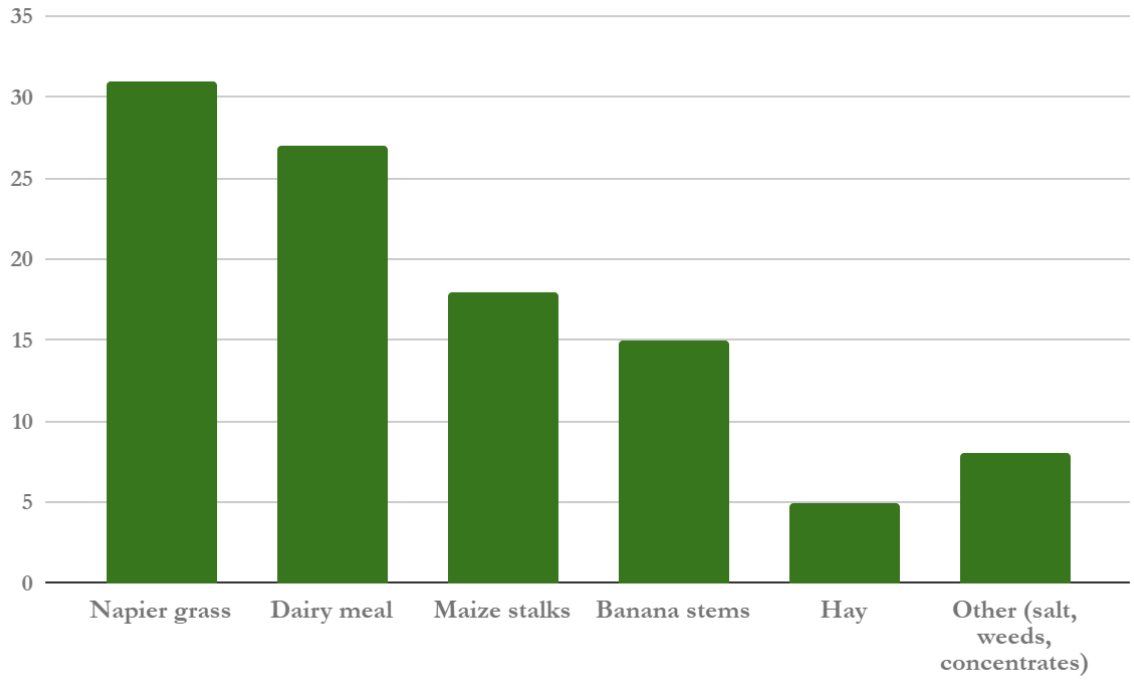


Source: Questionnaires

On average, a household would have two dairy cows that would both support the subsistence needs of the household and be a part of commercial production (questionnaires).

Furthermore, some respondents would utilise the manure from cows as fertilisers for other grown crops. Since all respondents practiced zero-grazing in relation to their livestock it meant that a majority would both grow and buy fodder for their cows. Figure 8 shows the variety of fodder that was given to the cows.

Figure 8: Types of fodder given to cattle



Source: Questionnaires

The farmers were connected to a communal water supply that would give them fresh running water from Mount Kenya. Every three days the water would be rationed between different villages, hence, farmers would have water tanks for storage. The amount of water needed would depend on the land size, but, on an average, farmers would pay 250KSh for water per month (questionnaires).

Physical capital

Apart from the family housing, most farmers would have wooden sheds for their livestock and additional storage space for fodder. From our observations it was clear that manual labour was the dominant way of dairy farming and only few farmers used machinery such as milking machines. However, we learned that quite a few farmers had a cutting machine for the fodder. In addition to the value of the cows' manure for fertilising purposes, a few

farmers would utilise the manure to produce biogas (SSI 8). This was a way to fully make use of the cows' potentials which contributed to secure the household in terms of gas for cooking. Furthermore, the local CBO has installed a milk cooler that farmers can access if they are members of the CBO. This gives farmers an opportunity to secure the quality of their milk when selling it to a bigger market.

Financial capital

Only four of the respondents indicated that dairy farming was their main activity, so the total income of the farmers would rely very much on the success of other crops. Of the farmers questioned, the dominant sources for income were coffee, tea, and macadamia farming (Figure 8). However, the cattle and other types of livestock had an additional value as they served as an informal insurance in that sense that it could be sold in case of money shortage (SSI 6, SSI 7). The estimated value per cow was 60072 KSh (questionnaire), so having cattle could be a way to maintain financial stability.

Respondents mentioned that loans where accessible, especially if you were a part of the local CBO. However, none of the farmers questioned ever took a loan through formal institutions. One informant explained that people would rather lend money from relatives than the formal institutions to avoid the instability of indebting themselves to that system (SSI 5).

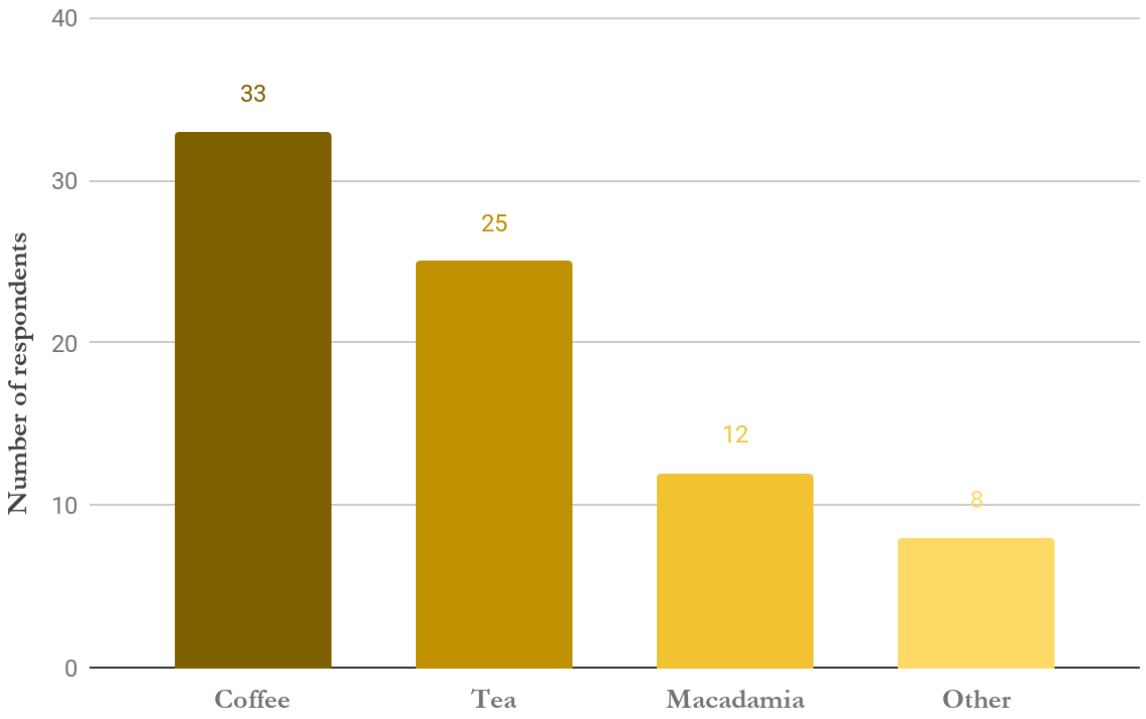
Social capital

In the area of study, it was very clear that one's relations to family and the local neighbourhood was an important part of the everyday lives of the farmers. Through our fieldwork we got to know about both formal and informal communities that could be of help to the farmers. If farmers were connected to the local CBO, they could both take advantage of the financial benefits related to loans and the widespread community of other farmers connected to the CBO. Through the CBO they could also access different forms of extension services such as training and education about how to improve farming practices (SSI 2). Both officials, employees in the CBO and farmers mentioned the advantages of grouping together and having a network to fall back on.

Livelihood Strategies

As mentioned before, in Kibugu, most of the farmers we have met were cultivating the land with different crops. Out of 33 farmers, 30 of them were producing coffee, 22 tea, 12 macadamia and 8 other plantations like bananas or avocados (Figure 9).

Figure 9: Various crop practices among dairy farmers

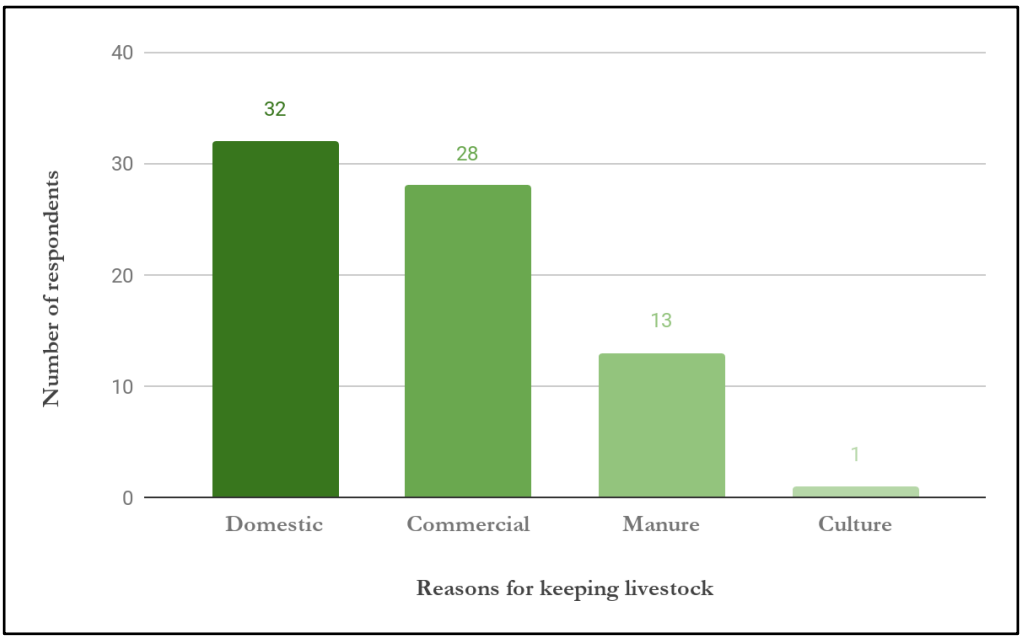


Source: Questionnaires

Dairy farming is thus part of a mixed farming practice and often serve as a supplement activity for different reasons. Integrating dairy production with crop farming seek to optimize farms' production despite the limited land available. Cattle is considered as one of the pillars of crop production and in the same time create capital assets (subsistence, sales). Within mixed farming practices, they represent a major advantage as they provide manure that enhance fields' efficiency by fertilising the soil and increasing the productivity of cash crops. Furthermore, having milk available every day for own consumption is a very valuable advantage for households since they consume every day 18.8% of the total milk produced (questionnaires). Even though the majority of the milk is sold, self-subsistence was found to be the main reason why farmers in Kibugu are keeping livestock (Figure 10). One informant mentioned the concern to have quality milk and that he could only be assured if it was his own milk (SSI 7). Thus, we would find many farmers in the village sustaining themselves as

this was the only way for them to ensure the quality of the milk. In addition to this, interviews and participant observation have been essential to ascertain that cattle represent an established heritage that is well passed on through generations and is well anchored in the rural Kenyan culture.

Figure 10: Reasons for keeping livestock



Source: Questionnaires

Two key informants stood out from our data collection, Mune's and Peter's farms. Mune's farm differed greatly by their livelihood strategy as dairy farming was his main activity. Through an interview, we have been able to distinguish his strategy from the "typical" farmer who practiced integrated dairy farming. His herd was composed of 113 dairy cows and he employed workers to maintain his activity. The cows were more efficient than all other respondents' as they produced up to 30 litres of milk per day. He can achieve that level of intensification because his financial capital allows him to get quality AI which ensures a productive breed. The knowledge he acquired also enhanced his production. For example, the supplement feeds he used was a mixed composition that he found was increasing milk production. Mune's dairy had a milk cooler where farmers can bring their milk against 30KSh and then sell it to Brookside for around 35KSh (SSI 6). The end goal for him is to be independent from Brookside and process the milk on site to add value to the milk collected.

Peter's farm was distinct by its development throughout the past years. His farm was previously composed of 30 cows which he now reduced to 3 to concentrate his farming activities on coffee production. He explained the shift by the decreased profitability in the dairy production. Back in the days, a litre of milk was sold on average at 45KSh, around 10 to 20KSh more than nowadays. Still, he has better equipment than other typical farmers, such as bigger lands and a milking machine. Also, he is not using AI but he uses bull insemination to guarantee the quality of the dairy breed (SSI 3).

We have been able to ascertain that farmers are firstly engaged in dairy production for subsistence needs but due to the level of milk produced they turn to commercial channels to sell surplus. Almost no farmers started for commercial purposes except Mune's farm who needed to scale up to make profit. On the other hand, Peter's farm represent a shift in the livelihood strategy as the loss of profitability made him scale down his dairy production until he had enough for self subsistence and selling the surplus.

Institutions and organisations

Institutional and organisational processes act as mediators between the inputs and outputs for subjects within the framework (Scoones, 2015). Therefore, it has been crucial for us to look at the different factors that shape the dairy industry in Kenya and farmers' access to it when assessing their livelihood strategies.

We have identified different actors that shape the institutional and organisational setting for the dairy sector. The institutions and organisations are revolved around traditions and the marketing of milk as this has turned out to be some of the main factors influencing the farmers' decision-making.

Traditional Heritage

In our field of study, the value of livestock has been sensitively attached to tradition, culture, household status and economic stability. The possession of cattle is an asset that provides security, prestige and status.

For a majority of the informants, dairy farming had been practiced in the family for more than 40 years, and as one informant expressed it: *"[…] it's wrong not to have a cow"* (questionnaires, SSI 7). This informant had inherited a herd of cows from his father and now mainly had the cattle for subsistence purposes. This fits into the tradition of having cattle as an important source of nutrition, and through our observations we learned that almost every

household would have a cow or other types of livestock to sustain their household needs (Figure 7). Another informant explained: *"It is more cultural than business. People keep cows not for economic viability. They keep them to be seen"* (SSI 6). This notion was common among the farmers in the area which implies that there is not only a responsibility from a heritage perspective but also that there exists a cultural norm related to the possession of cattle.

One of the economic roles that cattle play in dairy production is insurance against life hazard (health, poverty, investment or education). It was explained that having a cow acts like an investment in future expected or unexpected plans (SSI 3). Moreover, cattle is considered a crucial part of sustaining family ties as it has a central role in marriage traditions. Cattle is often a part of the bride dowry and is given as compensation for leaving kin with another family, and therefore we would also meet several farmers who had received their cattle in that context or who considered their cattle as valuable in regard to the future of their children.

County government

In our field of study, political structures were described as some of the main influencers to the development of the agricultural sector as a whole. Since 2013 much of the political decision-making has officially been laid out to the 47 counties to manage. Kibugu falls under the legal authority of Embu County, and, under the Agriculture Department, there is one agricultural officer and one livestock officer who take care of matters related to the agricultural sector such as extension services and meetings with the county government (SSI 1).

The livestock officer and the agricultural officer emphasised the strong ties between the national political processes and their work on the county level. If there is not any support from government side, the county strategies fall to the ground, and, therefore, it can be difficult to carry out ideas when the national government is not supporting. This is both related to economic factors but also political willingness. For long, livestock has not been prioritized on the political agenda, and this has reflected in decreasing opportunities for dairy farmers in the region (SSI 1). AI services, which were previously government financed, have been privatised, and as the livestock officer put it there are just too few people to take care of all the farmers: *"Our county government has [extension] services, but it's not sufficient. It's not enough. One person is covering a big area"* (SSI 1). The livestock officer proposed that farmers group together in order to share knowledge and also to be more accessible for him reach. As the extension services operate on a demand-driven level it means that the farmers

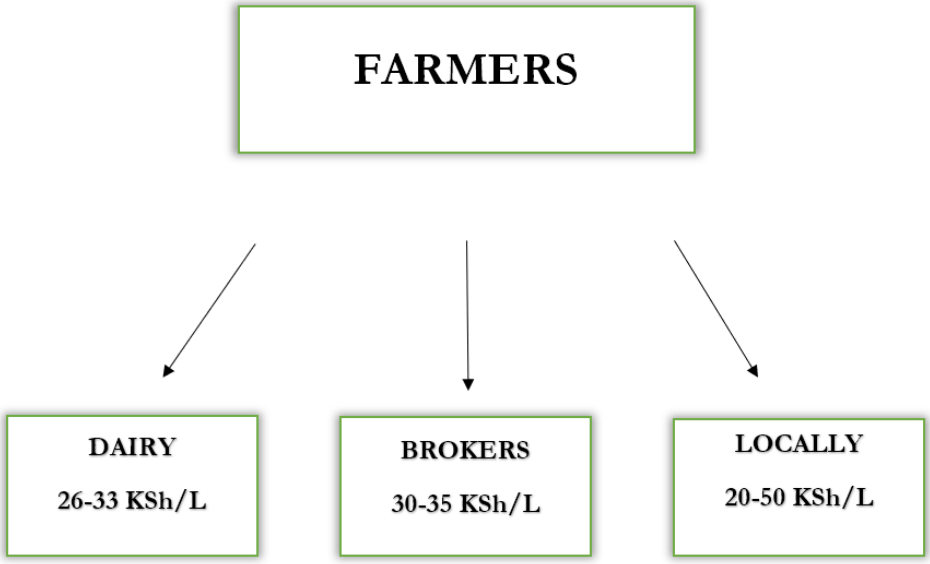
have to demand training in order for the livestock officer to deliver, and, therefore, they have to make themselves visible. However, more farmers expressed their concerns regarding the function of the officers as it could be difficult to locate the services and figuring out how to connect with the responsible officers (SSI 3, SSI 6). From officials' side, this imbalance between the number of farmers and number of officials limits their scope of action, while, from farmers' perspective, it can be discouraging to feel that the county government is not supporting their interests (SSI 6).

Even though this disconnectedness between farmers and officials can be considered an issue, there was one overriding factor that affected the possibilities for dairy farmers – both in the eyes of the county officials and the farmers themselves; the market.

Brookside

In our area of study, informants would either sell their milk through formal or informal channels. As shown on Figure 11 the farmers had a choice of whom to sell their milk to and at what price.

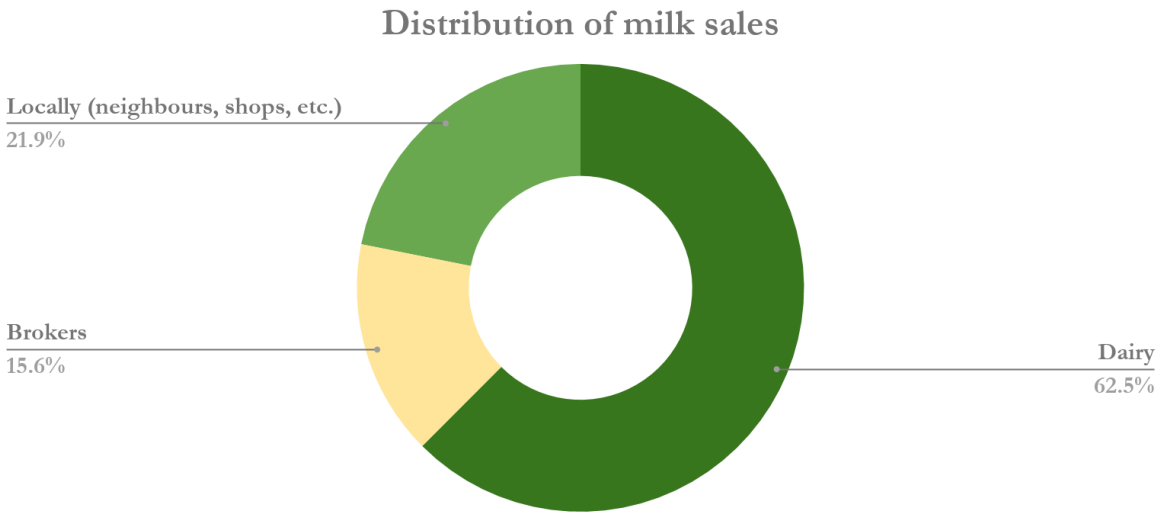
Figure 11: Milk buyers and pricing of milk



Source: Questionnaires

As Figure 12 shows, a majority of the respondents would market their milk through formal channels where Brookside Dairy was the main operator locally. Even though the pricing of the milk was lowest through the formal milk market many respondents chose this channel for marketing. One informant explained this was the only way to secure stability and continuity in their milk sales (SSI 5).

Figure 12: Distribution of milk sales



Source: Questionnaires

Brookside Dairy has been bought by the presidential family and is leading the milk market along with the government-owned company, The New KCC. Most informants would agree that the price of milk was dictated by the market forces which means that locally Brookside would be the ones controlling the prices of milk (questionnaires, SSI). What this means for the market is that there is no competitors to challenge the Brookside monopoly and that the dairy industry is closely connected to governmental processes and policies. Recently, 48% of Brookside has been bought by a French company which implies that this is a matter that goes beyond the national borders (SSI 6). This does not only have implications for the individual farmers, but will influence how the whole market is structured.

Photo 3: Brookside picking up milk from Kibugu CBO

Despite the low milk prices and general aversion to Brookside's powerful position, all the formal milk sales would still go through Brookside channels. One informant explained: *"We sell to Brookside, because they are consistent"* (SSI 6). More informants confirmed that they had to accept the circumstances of the market in order to secure their milk sales, because, otherwise, they would not have a market and consistency in their payments (SSI 3, SSI 7). This example again shows how the local situation is completely dependant of the national processes, and, in this case, it even has ties to a wider global tendency.

Kibugu CBO

Since 2006, the Kibugu CBO has been in operation. The CBO was established by farmers from the area who wished to create a market for their milk and has approximately 400 active members today. Previously, the farmers did not have many options of where to take their milk, thus the CBO if offering an alternative space for milk marketing and stands as a connecting link between the farmers and the wider structures in the industry (SSI 2).

In 2017, the county government donated a milk cooler to the CBO which really moved the local milk market. Every day, between 2500 and 3000 litres of milk leave the cooling plant. The cooler installation was partly financed by Lattana Dairy who the CBO set up a partnership with. However, there have recently been issues at the board of the dairy which

has resulted in the formation of a new dairy, Kenlink. Kenlink has taken over the role Lattana regarding milk controls at the cooling plant and now manages the connection from the CBO to the broader milk market. Despite the vision of offering alternatives to dairy farmers, the CBO remains constrained in the sense that the milk sales are dependant on Brookside's pricing, and this fact, along with uncertainty in the management, seems to be the main contributors to why farmers were hesitant to join the CBO.

In the local area, there has been various alternatives on the rise, and one of actors has been the Mune farm. Apart from the steps the family has made towards a large-scale intensive mode of farming, they have also invested in establishing a new dairy, Zen Dairy. Common to both the CBO and Mune's dairy was the wish to break free from the monopolised market and establish alternative local channels for farmers to market their milk.

Context

Trends

In our area of study, the majority of the dairy cattle was owned by smallholders who were taking care of most of the milk production. In fact, Kenyan highlands represent a privileged location for farming since temperatures and humidity enhance crop growth. The link between crop and dairy farming is indissociable since farmers grow the majority of the feeds used for dairy cattle on farm. For those reasons, a high density population inhabit the highlands, maintaining great market opportunities.

Most of the smallholders we questioned and interviewed were over 50 years old and this result illustrate the demographic situation in the Kenyan countryside (Figure 5). Indeed, the trend for younger people is to migrate to bigger cities, seeking for better education and opportunities. The government is currently trying to attract young people back to the countryside so they can participate in the rural development. The Kenya Youth Agribusiness Strategy is a recent program conducted by the Ministry of the Agriculture, Livestock and Fisheries, aiming to reintroduce youth in agriculture activities by reducing the negative perception of agricultural activities (SSI 1). This perception can be explained by the limited return from agricultural activities associated with risks, limited land availability or limited knowledge. The program intent to create network platforms, national campaigns and develop youth friendly financial models as a solution.

Challenges

High input costs

Farmers' inputs are an essential part of the cost benefit analysis which is needed to determine the profitability of dairy production. They face high input costs partly as a consequence of seasonality where farmers experience high feed cost during the dry season. Other costs have to be considered, those can be direct (e.g. veterinary services) and indirect (time spend on dairy production). Veterinary services including AI and the treatment of cattle represent an important part of the expected (AI) and unexpected (disease outbreaks) inputs. Almost all farmers questioned are currently using AI services which require a high cost to ensure quality services with the resulted breed expected. A more indirect input cost is the time spend on the dairy production, it comprises daily feeding, milking, and cattle monitoring. Farmers express this challenge (Figure 13) by noticing that dairy farming is a time-consuming activity.

The market

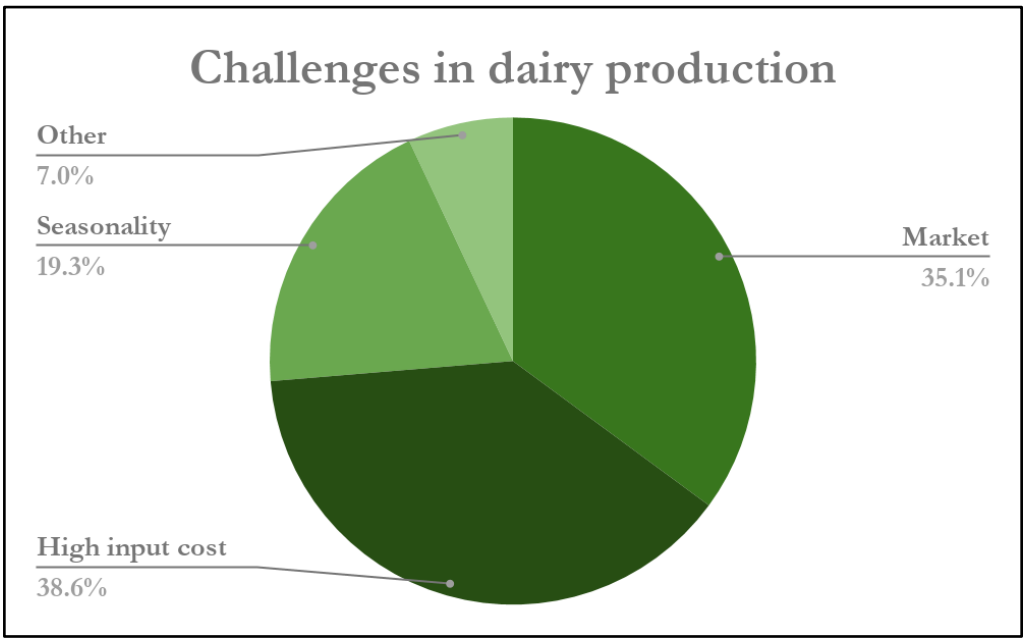
The Brookside monopoly previously described has a crucial influence on the market situation for farmers. The lack of market and competitors were a concern for most of the farmers (Figure 13) because they do not have sovereignty on the milk price and undergo price fluctuations created by the market. Those variations seriously impact farmers and render their activity unstable. Along with an unstable market, it has been found that some inconsistency in monthly payments from the CBO adds up to the overall unpredictability of the dairy activity. However, recent improvements in payment consistency have been observed by some farmers which indicates a development in the management within institutions. Nevertheless, low milk prices remain the main contributor to difficulties mentioned above when talking about high input costs. It was clear that milk revenues were too low to cover those input costs, threatening the viability of the activity.

Seasonality

One of the main challenges that farmers are facing is the seasonality and its consequence on feeds availability (Figure 13). Throughout the year, farmers have to deal with a variation in feeds stocks; a high availability during the rainy season due to high precipitations stimulating crops growth, whereas the dry season limit their growth and consequently their availability. Seasonality appeared to be the biggest obstacle for dairy production as the fluctuation of feeds stock impact the milk production directly and increases feed expenses at times where feed stocks are low. The surplus of the fodder harvested during the rainy season is often not

enough to go through the dry season and farmers need to buy feeds or use other feeds which are less efficient for milk production (Nyaata et al., 2000). Moreover, farmers noticed that droughts are more frequent and intense, which render this challenge even more important for the future of fodder in the dairy production.

Figure 13: Challenges expressed by farmers in the dairy production



Source: Questionnaires

Livelihood Outcomes

Farmers' livelihood strategies seek to improve the household stability, and as dairy farming is the only activity generating a daily production, it ensures a stable and regular revenue. Throughout the interviews and observations, we also perceived that food security is an important component of Kenyan culture. This is not only related to the nutritional value but also plays a part in assessing household status.

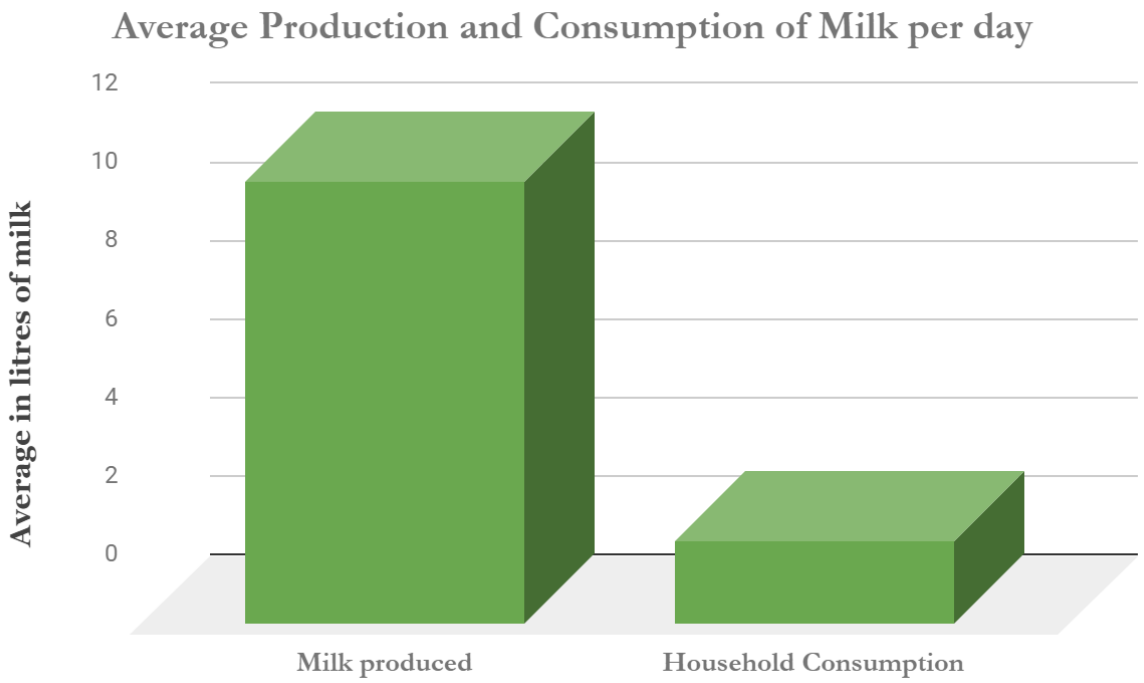
Cost-benefit analysis

By incorporating a cost benefit analysis we aim to attach tangible values to the livelihood outcomes of dairy farmers. The elements of this calculation were extrapolated via data in the questionnaire and were equated on a monthly basis.

Dairy farming generated a revenue through both sales of milk and own consumption of milk by the household. The monthly earnings from milk sales were stated directly by the

respondents during the completion of the questionnaire as a monthly value they acquired from dairy production. Moreover, Figure 14 shows that on average the respondents were producing 11 litres of milk and taking just over 2 litres of milk every day to provide towards food security.

Figure 14: Milk produced and consumed by households



Source: Questionnaires

The milk consumed by the household was an appropriate benefiting factor to consider, being one of the main reasons farmers practiced dairy production, as highlighted in Figure 10. The benefit of this household consumption was determined by multiplying the quantity of milk consumed daily, as recorded in the questionnaire, by the market price of milk in that region, namely 30KSh. The price determination was reasoned to the fact that raw milk was readily available from neighbours and the local community, which arouse the average price stated above. As highlighted in Figure 14, households are on average consuming 2 litres of milk per day, in effect "earning" themselves 1800KSh each month.

Apart from the commercial sales and domestic use of the milk, the production of manure appeared to play a significant role in all farming activities of the household. The manure has obvious benefits to the whole farming system. Yet there are also significant externalities for labour and costs which are difficult to account. While there is great potential for manure to offset the cost of fertiliser inputs for cash crop farming, factors such as quality, nutrient

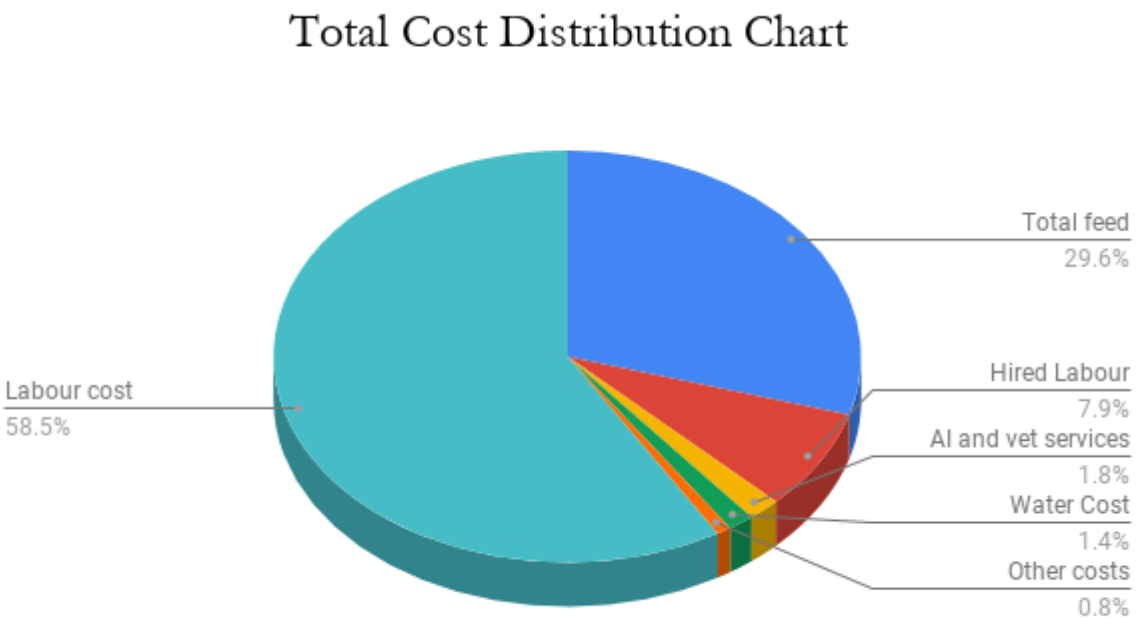
availability and pathogens and diseases make it difficult to quantify a realistic monetary value. The lack of knowledge and available information from the farmers also presents another challenge in determining a value. We can acknowledge that most farmers are using the manure as an input in their farming practices and thereby improving soil quality and saving money on fertiliser costs.

Moreover, by growing feeds on their own farms, respondents limit the influence of shocks from the market on inputs, evidently reducing their vulnerability. In general, dairy farming outcomes are not necessarily economical-related but are beneficial for the overall farming practices that form an intricate and complex web that sustains a household.

Furthermore, the costs assessed are labour, veterinary services, water, feed, AI services or bull insemination, and "other" costs incurred by farmers in the production of milk. Labour is divided into two sections, being hired labour and the cost thereof and the total time respondents/farmers would spend on dairy production on a daily basis. The time stipulated in hours was multiplied by the wage rate of 60KSh per hour, which was determined using the monthly salary for workers as stated by farmers. Labour played a significant role in the cost estimation, as seen in Figure 15, occurring for the highest average cost for farmers, yet it was the factor that farmers often overlooked in their production practices. Water aquired for dairy production was calculated using the official government related figure on the cost of water, which is 25KSh per cubic meter. Hence, one cubic meter of water is a thousand litres, providing an pricing of 0.025Ksh per litre. Farmers supplied us with an estimate on the volume of water used directly in dairy production per day, which was multiplied by 0.025 and 30 for the average monthly usage. The water contribution to irrigation, for fodder crops as an example, was not included in the estimate due to a lack of information or knowledge from the farmers. The cost of feed accounted for, on average 36.7% of farmers expenditure (see Figure 15), a significant portion of monthly costs. The contributions to the cost of feeds was namely dairy meal and fodder crops such as napier grass, maize stalks and banana plants. There was a general understanding that fodder crops were both grown by the farmers and bought in from various sources, only the amount farmers had to expend money on was accounted. The total cost of AI and veterinary services for a year were requested from farmers. For AI services the costs were dependent on the quality of semen, having higher value for better breeds and sexing. An average figure of 1633KSh was estimated for the cost of AI services with county vets costing 800KSh and upward of 2000KSh for private vets.

Many farmers did not require or use other veterinary services or were unable to provide valid information on the cost of such services, which resulted in variable data for this element. Due to the lack of data of veterinary services it was included together with AI services to generate a realistic value in the cost benefit analysis. To capture any costs the farmers felt were not included in the stipulated questions a "Other" costs was created. Farmers regularly included such items as milking jelly and salt concentrates, which were inexpensive but essential to the health of the cow.

Figure 15: Distribution of costs related to dairy production



Source: Questionnaires

A model farmer and the Monte Carlo Simulation

Due to the variable results we acquired through the questionnaires it was useful to construct a model farmer scenario. This scenario represents a "typical" farmer in the Kibugu location, who practices a mixed dairy crop production strategy, and maintains an average herd size of two cows. By calculating the standard deviation of each cost and benefit, adding and subtracting this from the mean value of said elements, a high and low profitability scenario was realised. Through analysing Table 1, a clear trend towards a lower profitability emerges.

The large values of the standard deviations show that there is significant variability between the different elements of farmers production profiles.

Table 1: Table showing the cost benefit analysis of a model farmer

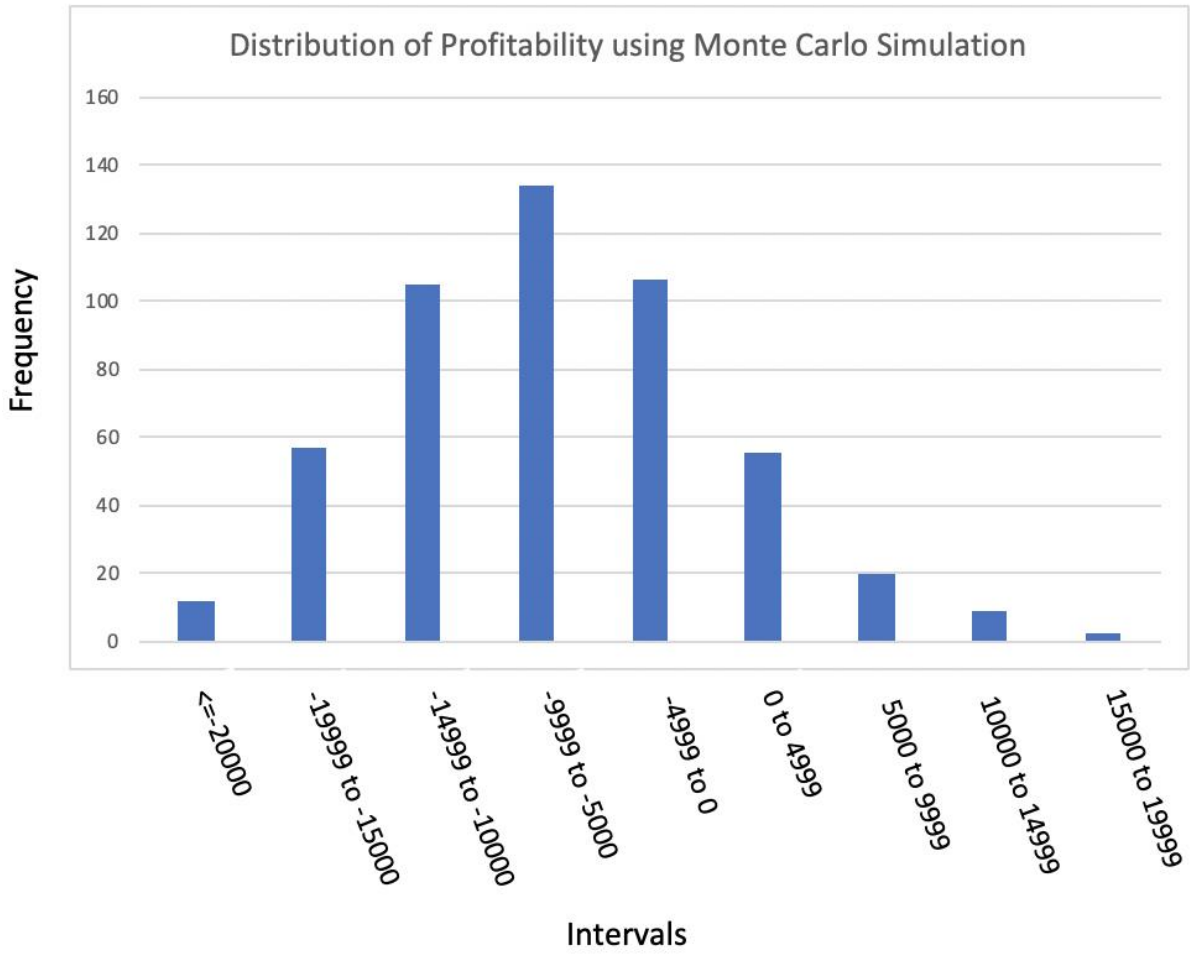
A model farmer keeping two cows				
Range	**Average**	**Low**	**High**	**Standard Deviation**
Benefits	9654,14	3598,194944	15710,12637	
Milk earnings	7745,52	2847,194944	12643,83954	4898,322297
Household consumption	1908,62	751	3066,286827	1157,666138
Costs	-16394,75	-26696,53516	-6092,97633	
Feed	-4337,08	-6980,846263	-1693,320404	2643,76293
Hired Labour	-5540	-9208,514686	-1871,485314	3668,514686
AI and vet services	-217,16	-403,6717093	-30,63863558	186,5165368
Water	-173,1	-302,016582	-44,1903145	128,9131338
Other	-205	-387,9459777	-22,05402227	182,9459777
Labour	-5922,41	-9413,539947	-2431,287639	3491,126154
Profit or Loss	-6740,61	-23098,34022	9617,150037	

Source: Questionnaires

Hence, by constructing a model farmer it enabled us to assimilate the questionnaire data and represent the respondents in a relevant manner. Due to the small sample size and large standard deviation it was necessary to create a simulation to more fairly represent the data, infer with greater accuracy and validate our results. Using the data from Table 1, we were able to create and run a Monte Carlo Simulation to forecast potential outcomes over a more significant data set. The data from the model farmer was used to extrapolate each element of the cost benefit analysis over 500 normally distributed random values, using the formula =NORMINV(probability;mean;standard deviation). The results of each cost and benefit were equated to provide a simulated profitability result, giving an average value of -6849.06 KSh (loss) for the model farmer in this simulation. Furthermore, a frequency distribution, Figure 16, was constructed to visually present the trends in profitability for dairy production in

Kibugu location. The evidence shows that farmers are normally distributed with the mean falling below zero. The simulation confirms our initial cost benefit analysis of the 30 respondents, showing that dairy farmers are typically occurring a loss in their production.

Figure 16: Frequency distribution of farmers profitability in Monte Carlo Simulation.



Source: Monte Carlo Excel Spreadsheet

The cost benefit analysis thus indicate that farmers are making a loss on dairy farming from an economic perspective. However, only few farmers were articulated this loss as they incurred benefits from the dairy farming related to other aspects of their livelihoods. Thus, we cannot only take the economic perspective into account when assessing the reasoning behind different livelihood strategies.

Reflections on Analysis and Methodology

Using SLF has been a way meaningful way for us to capture the empirical data as it enabled us to say something general based on the individual experiences of the informants. By grouping the data and characterising the "typical" farmer, we were able to discuss the results on an overall level and draw parallels across the farming practices. Doing it this way, we do acknowledge that we produce a rather static measurement of the farmers' livelihoods that only captures a certain point in time from a certain perspective. However, for the purpose of the research, it made sense for us to group the farmers in order to integrate the characterization of farm systems and the cost benefit analysis into the framework.

When it comes the methods used to obtain these results, we faced various challenges on the way. Given the time we had, we had to prioritise and comprise on how to spend our days and this limitation meant that we could not necessarily follow up on all the information we got from informants in a comprehensive manner. For example, we remain with a sample size of 33 respondents to our questionnaires which has proven to be difficult in our analysing process. Furthermore, we realised along the way that some questions in the questionnaires could have been phrased better to capture all the different aspects we were interested in. In our analysis, it was necessary to remove participants with missing data to retain authenticity of the cost benefit calculations. Furthermore, from our analysis of the results, it is clear a more in depth study would be warranted.

We encountered some challenges related to the language barrier occurrent in the field. When carrying out questionnaires and semi-structured interviews, the translators would often play a crucial role in the data collection as many farmers did not speak English. As we did not understand the local dialect, Kiembu, it was difficult for us to participate at times and also to ensure that the questions were asked in the right manner. The slightest miscommunication could have consequences for how informants perceived the questions asked, which can explain some variations in the answers given. Due to this, we sometimes felt that information got lost in translation.

Where the quantitative data was weak, we could support it with observations and interviews. Thus, we were able to do a comprehensive analysis by triangulating the data obtained through different methods.

Discussion

As researchers, it is our aim to be transparent with our study and the data we have collected. Evidently, it was challenging to acquire a comprehensive analysis of all elements of smallholders livelihoods from this exercise. Turning to existing literature on the topic of smallholder dairy production, we aim to compare and discuss our results.

By ascertaining the livelihood strategies of the farmers in Kibugu, we found common patterns in the way of farming and decisions made related to dairy farming in particular. Crop-dairy production systems dominate smallholder agriculture in Kibugu and Kenya alike, initiating an intensification of farming systems and complementary interactions for incomes (Muriuki et al., 2001). As we only spoke to a few farmers for whom dairying was their main activity, we can confirm the trend of practising crop-dairy systems as a common strategy for smallholders in Kenya (Thorpe et al. 2000; Bebe et al. 2002).

In line with the trend of decreasing land size (McDermott et al., 2010), it was evident in our area of study that the practice of dairy farming could not be isolated from other farm activities. Having cattle is a land-consuming practice when taking all the different factors (e.g. growing fodder, storage space and milking shed) into account. In relation to decreasing land availability, Baltenweck et al. (2006) describes an imbalance between farmers desire to intensify dairy production and the ability to maintain improved cattle.

The seasonality of feeds and high input costs were recurring challenges faced by the respondents, similarly faced by many smallholders in Kenya (Omore et al., 1999; Bebe et al., 2003). Farmers breed preferences for large mature size dairy cows thus presents a contradiction in development strategies, as these larger cows have shown higher nutritional demand, low milk yield and poor adaptability in this setting (Bebe et al., 2003). Yet, as shown in our research, the breeding decisions of smallholders in Kenya specifically, are based more on farmers perception of breed attributes. As an example, Friesians have higher market value due to their overall size and cultural heritage, thus represent a better storage of wealth for smallholders (Bebe et al., 2003). Moreover, dairying is practised to produce milk for feeding the family and for sale, to produce manure to support crop production, to provide dairy animals for insurance and financing emergency cash needs, and for social status, which combined with farmers experiences inform the decision making process. Highlighting the differing attitudes of various development agendas, which focus on market related costs and benefits of livestock systems (Bebe et al., 2003).

Thorpe et al. (2000) describes how policy-makers are facing challenges when it comes to increasing the market access for smallholders as their input costs of having cattle remain high. As illustrated in the the SLF, dairy farmers in Kibugu are facing major challenges regarding the high input costs they occur. This can be a discouraging factor for farmers when assessing the possibility of intensification in their local setting. In addition to this, we also found a weak link between the farmers and the public livestock services. More scholars are pointing at the private sector to fill the gap of giving efficient services, such as veterinary services, to smallholders (Baltenweck et al., 2006). As more of the informants indicated, the private services are unaffordable and mark a distortion between the aims for development and the actual capabilities of the farmers.

Muriuki et al. (2001) found that a majority of smallholder dairy producers utilise the informal milk market as their primary outlet, realising significant advantages to low-income members and providing a source of employment for small-scale market agents. In Kibugu, however, we found that the majority of informants would sell their milk via formal channels, the reason being that the formal market was the only channel securing consistent payments for the household. While, limited off-farm job opportunities were created in Kibugu, an important trend emerged not reflected in the literature. Through participant observation, questionnaires and key informant interviews the significant role of women in dairy production was highlighted. The daily tasks from milking to cutting of fodder, and general maintenance of the herd is managed mostly by women. Thus providing permanent employment to a marginalised group and a consistent revenue to the household.

Recommendations

After analysing the different components of dairy farming along with the challenges faced by farmers, we have been able to reflect on recommendations that could be useful for farmers, extensions officers and any other active layer of the dairy production.

- **Record keeping:**

  We noticed a lack of record keeping among the majority of the respondents. Be aware of the cost and benefits and keeping track of breeds as well as production performance, is a useful tool to keep the activity profitable.

- **Intensification:**

  We can propose two methods for enhancing milk production to increase profitability. One dairy intensification strategy would be to increase the herd size or pool cattle

together under one roof, aiming to employ economies of scale and reducing production costs per head. Or continue to intensify on a small scale by improving breeds, feeds and rationing, incorporating small mature dairy cows such as Jersey and focusing on animal health. We believe both dairy farming intensification methods can be viewed as a viable livelihood strategy for farmers in Kibugu.

- **Farmers grouping:**

  Groups of farmers have proven to obtain great improvements for dairy production (e.g. CBO). More groupings would help farmers to have greater power on the price they are selling their milk at. An idea of Mune was to gather farmers' cows in his farm, process the milk on site and do value addition.

- **Storing fodder to avoid seasonality**

  One of the biggest challenges expressed by farmers was seasonality causing expensive feeds. Farmers should store fodder and water for dry seasons to minimise the market's impact.

- **More trainings and extension services**

  Extension officers have put in place services and trainings, however, the extent of their actions if often limited as they don't have the possibility to reach out to all farmers. The importance of livestock should be emphasised on county government level.

- **Veterinary services**

  Farmers should place more emphasis on animal health which is directly related to the productivity of the cow. By employing professional and trusted veterinary services farmers can improve their outputs while maintaining their current resource base.

Conclusion

Our study highlights the reasons why farmers keep integrating dairy farming as part of their farming activities. The main reason being for subsistence purposes, the gain of stable incomes from the milk surplus, the materialised insurance (cattle) and culture are also significant drivers. Our study supplemented by the literature, point out many challenges minimising improvement or intensification possibilities. Those are high input costs often driven by seasonality, decreasing land availability and the lack of market (or choice of market). While the profitability of dairy farming is low, it still presents a viable livelihood strategy for smallholders. However, the future of milk production depends on the

development of different actors including extension officers, processors and the farmers themselves. Mune's and Peter's farms propose a model farm scenarios in which dairy intensification would be a viable livelihood. This require help from extension officers to acquire a sufficient capital needed for intensification.

Learning experience

The fieldwork was conducted by three students from the University of Copenhagen and four students from the university of Nairobi with various academic backgrounds such as environmental governance, veterinary science, agricultural development, climate change, and anthropology. Working interdisciplinary on a project has been a giving experience from which we have all learned from each other and contributed with knowledge from our respective disciplines. From an academic perspective, it has been an experience that has pushed us to think beyond our usual learning schemes and engage in new methods and approaches. This also implies compromising about these exact methods and approaches in order to capture the different aspects of our project in the best way.

Within the first days of field work, we realised that there was a significant difference in how each country group had prepared for the field work and, therefore, the first days of field work were centred around finding a common ground of interest and discussing expectations for the field work (Dahl et al, 2012). The difference in preparation ties to the fact that there is not a shared academic output between the involved universities and that the students therefore can be engaged at different levels to the project (Bob et al., 2005). We experienced that this had an influence on the work ethic as there would sometimes occur an imbalance in the distribution of work based on levels of group participation (ibid.). Furthermore, the fact that we were seven people resulted in time-consuming discussions on an everyday basis.

However, it was extremely giving to work with our Kenyan counterparts as they had detailed insight into the traditions and customs of the country which could help us all navigate in the field. Socially, we also got along really well which was an enrichment to our stay.

The interdisciplinarity has also been a part of the post-field work process as we continuously have discussed and assessed the strengths and weaknesses of various approaches to capture and analyse our data.

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Appendices

Appendix 1: Research questions and sub-questions

Research questions and sub-questions:

1. What conditions are influencing dairy production?
    a. What are the demographic structures in dairy production?
2. What are the farmers production possibilities?
    a. What assets do the farmers possess?
    b. What do farmers consider advantages and disadvantages in the production?
3. How is the dairy production structured? (classification of production system)
    a. What are the production strategies of the individual farmers?
    b. What does a regular day of production look like?
4. What is the value of dairy production?
    a. What are the costs and benefits of dairy production?
    b. What are the livelihood outcomes?
5. How is the milk market structured?
    a. What are the different marketing strategies, their benefits and disadvantages?
    b. Which associations, cooperatives, and organisations are prevalent in the local setting?
    c. How is the milk distributed?

Appendix 2: Data matrix

Questionnaires	33
Semi-structured interviews	8
Transect walk	1

Appendix 3: Questionnaire

GPS point: x:_____ y:_____ z:_____	**Interviewer:**
Sub-location:	**Note taker:**
Date and time:	**Translator:**

Introduction

We are postgraduate students from the University of Nairobi and University of Copenhagen. We are conducting a research on sustainable land use management system (SLUSE). The research focus on dairy production/farming, marketing of milk and the cost benefit analysis of dairy production. Dairy farming is a major agricultural activity here in Kibugu and almost every household does dairy farming. The information collected will only be used for academic purpose and it will be kept confidential.

Section A: Bio-data

Gender:

- ❑ Male
- ❑ Female

Age group:

- ❑ < 20 years
- ❑ 21-30 years
- ❑ 31-40 years
- ❑ 41-50 years
- ❑ > 50 years

Marital Status:

- ❑ Single
- ❑ Married
- ❑ Divorced
- ❑ Widow/Widower

Head of the household:

- ❑ Male (father)

- ❑ Female (mother)
- ❑ Youth headed family (brother/sister)

How many members are within your household?

_____

___

Level of education:

- ❑ Primary level
- ❑ Secondary level
- ❑ Tertiary level (anything after college)
- ❑ None

Occupation:

- ❑ Government employed
- ❑ Self employed
- ❑ Private sector/NGO

Is dairy farming your major income generating activity?

- ❑ Yes
- ❑ No

If no, explain:

_____

Animals reared at the homestead:

- ❑ Cows
- ❑ Chicken/Poultry
- ❑ Rabbits
- ❑ Goats
- ❑ Sheep
- ❑ Pigs
- ❑ Other:

_____

Reason for keeping dairy livestock:

- ❑ Culture/tradition
- ❑ Commercial purpose (produce milk for selling)
- ❑ Domestic purpose (for own consumption)
- ❑ Gift/inheritance
- ❑ Other:

_____

For how many years have you practiced dairy farming?

- ❑ < 10 years
- ❑ 10-20 years
- ❑ 21-30 years
- ❑ 31-40 years
- ❑ > 40 years

Section B: Dairy production and sales

How much land do you have?

- ❑ < 1 acre
- ❑ 1-3 acres
- ❑ 4-7 acres
- ❑ > 7 acres

What size of land do you use for dairy farming? (fodder, stalls, etc.)

_____

___

How many cows do you have?

_____

___

What breed of cows do you keep?

- ❑ Local breeds (Zebu)

- ❑ Improved breeds (local mixed with dairy)
- ❑ Hybrid (mix of two dairy breeds)
- ❑ Dairy breeds (Friesian etc.)

Total estimated value of herd?

_____

___

How many liters of milk do your cow(s) produce per day?

_____

___

How much milk does your household consume in a day?

_____

___

Who do you sell your milk to and for how much?

_____

__

_____

__

_____

__

_____

__

_____

__

Do you do value addition to the milk?

- ❑ Yes
- ❑ No

Monthly earnings from milk sales and other milk products?

_____

___

Type of feeding method:

- ❑ Zero grazing

- ❑ Rotational grazing
- ❑ Herding

What type of feed? (Fodder, dairy meal, etc.)

_____

_____

_____

_____

Where do you get the fodder for the cows?

- ❑ Growing on own farm
- ❑ Buying

Do you give nutrient supplements to the cow(s)?

- ❑ Yes
- ❑ No

  Costs:

_____

What is the total cost for feed (including supplements) per month?

_____

___

Do you employ anyone to help in the dairy production?

- ❑ Yes
- ❑ No

  If yes, what is the cost?

_____

How much money do you spend on veterinary services per year?

_____

___

Between AI (artificial insemination) and mating which one do you prefer for your cow and what is the cost?

- ❑ AI
  Cost:

  _____

- ❑ Bull-cow mating
  Cost:

  _____

Total cost of water for dairy production? (animals and domestic consumption)

_____

__

Other costs associated with dairy production (calves, milking jelly, etc.)?

_____

__

Total time spent on dairy production per day?

_____

__

Section C: Structure of the milk market

Are you a member of any dairy grouping (cooperatives, associations, chama, etc.?

- ❑ Yes
- ❑ No

If yes, which one?

_____

In your view, what are the advantages/disadvantages of being a member of a grouping?

_____

___

_____

___

In your view, who controls the price of milk?

_____

___

Are there financial institutions available to give loans for dairy production?

- ❑ Yes
- ❑ No

Are loans flexible to pay back?

- ❑ Yes
- ❑ No

Have you ever used a loan for dairy farming?

- ❑ Yes
- ❑ No

If yes, how did it help to improve your farming?

_____

_____

_____

_____

Do you have other sources of income to supplement dairy farming?

- ❑ Yes
- ❑ No

If yes, what?

_____

In your view, what are the challenges to your dairy production?

1_____

___

2_____

___

3_____

___

4_____

___

Notes:

Appendix 4: Interview Guides for Farmers, Officials, and Head of CBO

Background:

We are postgraduate students from the University of Nairobi and University of Copenhagen. We are conducting a research on sustainable land use management system (SLUSE). The research focus on dairy production/farming, marketing of milk and the cost benefit analysis of dairy production. Dairy farming is a major agricultural activity here in Kibugu and almost every household does dairy farming. The information collected will only be used for academic purpose and it will be kept confidential. We will be recording this conversation.

Ask for consent.

Farmers

- Basic formalities (Name, age, details on household)
- What do you do for a living?
- When did you start dairy farming?
- Why do you do dairy farming? (commercial vs subsistence)
- Whom do you prefer to sell your milk to and why?
- How do you think cooperatives can add value to your production?
- Are farmers represented at the board of the cooperatives and involved in the decision at the cooperatives?
- Do you have an influence in determining price?
- Are there farmers groups where you are taught about better farming and how to increase milk productivity? Tell us more. (combining nutrients, etc.)
- Is dairy farming beneficial to your livelihood and would you continue in the future? (Possibilities or other alternatives?)
- In your view what are the challenges you face?
- Do you think dairy production is a profitable activity to pursue?

Livestock officer and agricultural officer

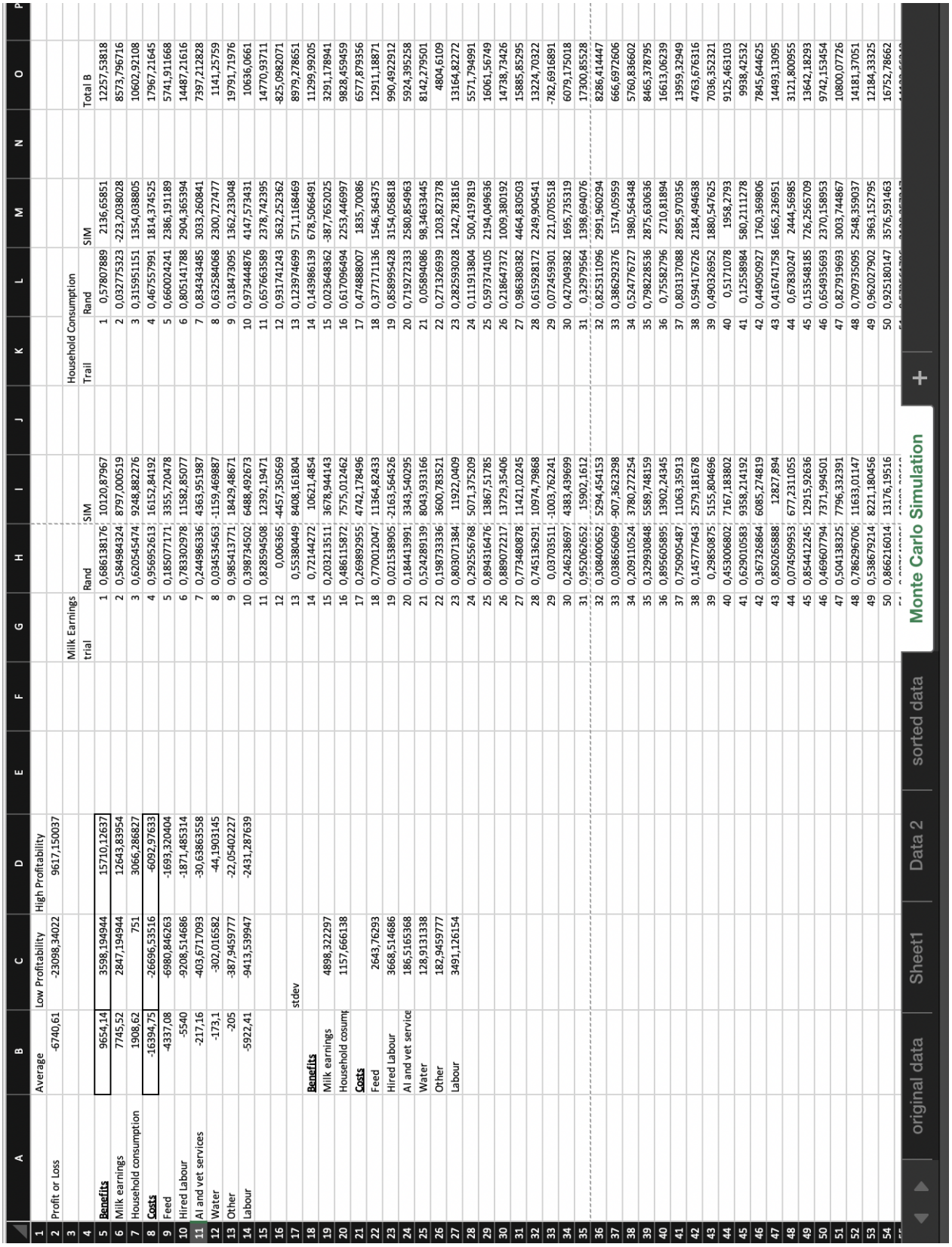
- Which areas related to livestock are you responsible for handling? (what is your role)
- Can you summarize the common dairy production strategy?
- What are the common livestock diseases that they encounter?
- Who handles and ascertains the quality of artificial insemination.
- Does the county or national government offer any subsidies?
- Are there extension services offered to dairy farmers? (advice, training, etc.)
- Do you encounter any issues related to the local dairy sector?(What are the issues?)
- Who is involved in the decision making revolving the local dairy industry? (from government level to local farmers)
- How is the local livestock sector developing? (strategies to improve)
    - Are there any changes specific to dairy production?
    - Pricing?
- In your view, do you see any future potentials for dairy production?
- Do you think dairy production is a profitable activity to pursue?

Head of CBO

- Outline your role in the local dairy sector.
- What are the benefits that farmers' occur from being members of an association, CBO, or other groupings?
- How do you determine the price of a liter of milk (35 shillings)? (what mark-up do you make on the milk)
- What is the role of brokers in the dairy market?
- Do you acknowledge any knowledge gaps in the dairy practices?
- What do you do to attract farmers to become members of the CBO?
- Are there extension services offered to member dairy farmers? (training, advicing, providing knowledge on value addition, etc.)
- It is possible for the dairy farmers to access microfinance institutions?
    - Are any farmers using the credit opportunities through ECLOF (microfinance institution)?
- Do you have meetings with the dairies andies discuss issues about milk production?
    - Link to lantana
- Are the farmers represented in decision making processes?

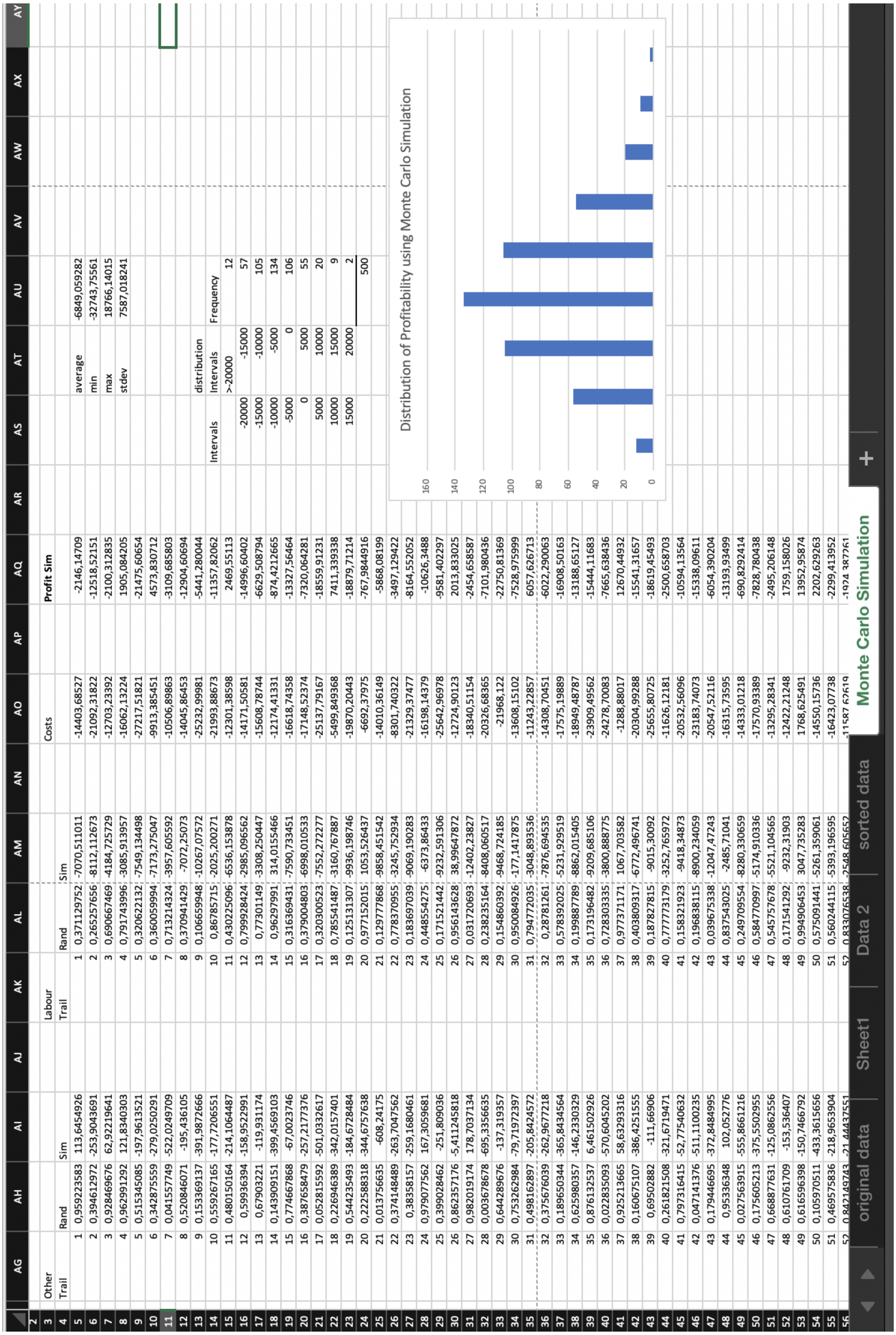
- How do you feel about the monopoly on the dairy industry? (consequences for farmers)
- Do you think dairy production is a profitable activity for farmers to pursue?

Appendix 5: Monte Carlo Excel Spreadsheet



Feed			Hired Labour			AI			water		
Trial	rand	sim	trial	rand	sim	Trail	Rand	Sim	Trail	Rand	Sim
1	0,051510093	-8647,431012	1	0,976662045	1757,51654	1	0,359037984	-284,4983278	1	0,220549094	-272,4069535
2	0,533466736	-4115,037488	2	0,230570487	-8243,582975	2	0,76387279	-83,08896589	2	0,193557944	-284,5917533
3	0,655230782	-3280,945563	3	0,57749409	-4822,853571	3	0,377278163	-275,4720044	3	0,410827344	-202,1592451
4	0,127969357	-7340,507445	4	0,552204158	-5058,573024	4	0,280651402	-325,5088534	4	0,060062624	-373,4629929
5	0,020222636	-9754,605715	5	0,161964191	-9158,686336	5	0,258907794	-337,7832798	5	0,359892686	-219,3470263
6	0,304675194	-5688,045385	6	0,99342761	3557,265188	6	0,716869103	-110,1805302	6	0,357638643	-220,1246481
7	0,785630062	-2244,938648	7	0,714124083	-3465,55265	7	0,735776455	-99,58401812	7	0,366162429	-217,1927516
8	0,494133541	-4375,958018	8	0,822885797	-2141,419221	8	0,747998708	-92,52867082	8	0,514938192	-168,2717843
9	0,81727557	-1944,392074	9	0,040261441	-11951,31717	9	0,36042285	-283,8077236	9	0,043006598	-394,4198496
10	0,03820176	-9021,685185	10	0,09847581	-10273,43056	10	0,155877399	-405,8302043	10	0,740363399	-90,01984917
11	0,381559261	-5133,878843	11	0,927366503	-196,9749558	11	0,904109906	26,30580325	11	0,284346292	-246,577657
12	0,863484427	-1439,228079	12	0,149164634	-9355,339239	12	0,784640378	-70,19215558	12	0,532157358	-162,6974797
13	0,712778644	-2852,552732	13	0,179617903	-8903,37578	13	0,720036524	-108,4301826	13	0,133410033	-316,2471287
14	0,59032244	-3733,311991	14	0,275073439	-7732,084441	14	0,041017737	-541,5115041	14	0,759962163	-82,06401264
15	0,856566631	-1521,418777	15	0,328943735	-7164,534605	15	0,822757768	-44,45949805	15	0,327799692	-230,594876
16	0,405119428	-4971,894806	16	0,608320649	-4531,361225	16	0,580011959	-179,4978213	16	0,385739567	-210,5416171
17	0,165136722	-6910,950409	17	0,13210886	-9635,814752	17	0,553174266	-192,2254897	17	0,090562433	-345,4954803
18	0,805830157	-2056,4848	18	0,943179752	263,7360485	18	0,775523314	-75,93694014	18	0,635666731	-128,3800495
19	0,25155037	-6107,393719	19	0,732999787	-3258,510551	19	0,044538352	-534,2918905	19	0,99401514	150,8633193
20	0,767879496	-2402,159292	20	0,624852061	-4372,497957	20	0,36410159	-281,9776101	20	0,091706629	-344,5955641
21	0,732384352	-2697,840602	21	0,917354952	-449,9448453	21	0,342160899	-292,9925454	21	0,70699555	-102,8902055
22	0,972320367	728,490873	22	0,576877672	-4828,630362	22	0,056367508	-512,9787584	22	0,481239712	-179,164385
23	0,248993489	-6128,653705	23	0,513503866	-5415,800095	23	0,447824714	-241,6233463	23	0,372759253	-214,9392972
24	0,275259678	-5915,359047	24	0,673430513	-3891,348357	24	0,711255312	-113,2599008	24	0,784420921	-71,61811886
25	0,341979574	-5413,267319	25	0,088006308	-10503,99436	25	0,693851257	-122,6340385	25	0,663558065	-118,6737276
26	0,168287922	-6877,611689	26	0,485667649	-5671,822972	26	0,857976463	-17,35002646	26	0,442632977	-191,7017773
27	0,841119688	-1695,774905	27	0,632866183	-4294,707473	27	0,707544747	-115,2797938	27	0,895400236	-11,21480982
28	0,72520728	-2755,101301	28	0,287076601	-7601,505045	28	0,062563254	-503,2029577	28	0,069865404	-363,4781698
29	0,184500607	-6712,093362	29	0,526456469	-5296,538227	29	0,758099875	-86,56047525	29	0,233454898	-266,8863932
30	0,227561854	-6311,707486	30	0,379731586	-6663,247162	30	0,545734661	-195,7307308	30	0,47679039	-180,6041267
31	0,19624564	-6597,783217	31	0,885604037	-1125,028271	31	0,771393621	-78,49535207	31	0,456496029	-187,1857338
32	0,789803602	-2206,894526	32	0,703399204	-3580,271089	32	0,752267014	-90,02267803	32	0,178474666	-291,8539606
33	0,354510265	-5323,657957	33	0,41406053	-6336,478575	33	0,647428688	-146,5844416	33	0,507411475	-170,7049381
34	0,185789486	-6699,334039	34	0,777514	-2737,899624	34	0,243724442	-346,6718797	34	0,548669392	-157,3338885
35	0,360625554	-5280,340811	35	0,186078585	-8813,92904	35	0,04495818	-533,4620322	35	0,768378151	-78,54013801
36	0,001429814	-12221,93838	36	0,3589843	-6864,975937	36	0,152243556	-408,6860861	36	0,032146808	-411,6071293
37	0,337533768	-5445,354235	37	0,991836056	3269,947997	37	0,682657663	-128,5378745	37	0,684245978	-111,2725719
38	0,044252176	-8840,308649	38	0,693379192	-3685,74302	38	0,383537356	-272,4068422	38	0,087912631	-347,6124746
39	0,717132487	-2818,650572	39	0,015515156	-13451,82608	39	0,865648686	-10,86241453	39	0,281929572	-247,4982048
40	0,783274548	-2266,220233	40	0,532795053	-5238,089268	40	0,404705695	-262,1450742	40	0,19220344	-285,2293116
41	0,395339505	-5038,811309	41	0,52794589	-5282,810172	41	0,077108339	-482,9076931	41	0,257810744	-256,907654
42	0,079792739	-8055,445494	42	0,503516256	-5507,665487	42	0,610384943	-164,8752242	42	0,840924723	-44,41044506
43	0,903541531	-894,9049423	43	0,398635759	-6482,367541	43	0,019260038	-603,1144285	43	0,580788115	-146,813313
44	0,5117017	-4259,522519	44	0,12048339	-9841,604037	44	0,951904444	93,13010364	44	0,973300117	75,91813881
45	0,91664298	-681,179811	45	0,592869129	-4678,149593	45	0,779349511	-73,54260773	45	0,801431507	-63,94338273
46	0,672309076	-3157,173332	46	0,233166814	-8212,356721	46	0,115169172	-440,8843016	46	0,387172475	-210,0589052
47	0,839556461	-1712,784138	47	0,514889798	-5403,047534	47	0,192525627	-379,1732754	47	0,558624195	-154,0876369
48	0,606185135	-3624,877218	48	0,960555465	906,1989174	48	0,900469303	22,3701837	48	0,097651524	-340,048929
49	0,782334355	-2274,677279	49	0,976771338	1764,799212	49	0,347927619	-290,0733305	49	0,114144495	-328,4117161
50	0,887663501	-1127,034384	50	0,346709842	-6986,19658	50	0,130705766	-426,6294732	50	0,134533948	-315,5762956
51	0,155966443	-7010,385836	51	0,710220071	-3507,541079	51	0,588154523	-175,6040641	51	0,667200065	-117,3844196
52	0,18445413	-6712,554503	52	0,848665734	-1758,760305	52	0,337380604	-295,426546	52	0,273253848	-250,834812

original data | Sheet1 | Data 2 | sorted data | Monte Carlo Simulation



Row	Other Trail	Rand	Sim	Labour Trail	Rand	Sim	Costs	Profit Sim
5	1	0,959223583	113,6454926	1	0,371129752	-7070,511011	-14403,68527	-2146,14709
6	2	0,394612972	-253,9043691	2	0,265257656	-8112,112673	-21092,31822	-12518,52151
7	3	0,928469676	62,92219641	3	0,690667469	-4184,725729	-12703,23392	-2100,312835
8	4	0,962991292	121,8340303	4	0,791743996	-3085,913957	-16062,13224	1905,084205
9	5	0,515345085	-197,9613521	5	0,320622132	-7549,134498	-27217,51821	-21475,60654
10	6	0,342875559	-279,0250291	6	0,360059994	-7173,275047	-9913,385451	4573,830712
11	7	0,041557749	-522,0249709	7	0,713214324	-3957,605592	-10506,89863	-3109,685803
12	8	0,520846071	-195,436105	8	0,370941429	-7072,25073	-14045,86453	-12904,60694
13	9	0,153369137	-391,9872666	9	0,106659948	-10267,07572	-25232,99981	-5441,280044
14	10	0,559267165	-177,7206551	10	0,86785715	-2025,200271	-21993,88673	-11357,82062
15	11	0,480150164	-214,1064487	11	0,430225096	-6536,153878	-12301,38598	2469,55113
16	12	0,59936394	-158,9522991	12	0,799928424	-2985,096562	-14171,50581	-14996,60402
17	13	0,67903221	-119,931174	13	0,77301149	-3308,250447	-15608,78744	-6629,508794
18	14	0,143909151	-399,4569103	14	0,96297991	314,0155466	-12174,41331	-874,4212665
19	15	0,774667868	-67,0023746	15	0,316369431	-7590,733451	-16618,74358	-13327,56464
20	16	0,387658479	-257,2177376	16	0,379004803	-6998,010533	-17148,52374	-7320,064281
21	17	0,052815592	-501,0332617	17	0,320300523	-7552,272277	-25137,79167	-18559,91231
22	18	0,226946389	-342,0157401	18	0,785541487	-3160,767887	-5499,849368	7411,339338
23	19	0,544235493	-184,6728484	19	0,125131307	-9936,198746	-19870,20443	-18879,71214
24	20	0,222588318	-344,6757638	20	0,977152015	1053,526437	-6692,37975	-767,9844916
25	21	0,013756635	-608,24175	21	0,129777868	-9858,451542	-14010,36149	-5868,08199
26	22	0,374148489	-263,7047562	22	0,778370955	-3245,752934	-8301,740322	-3497,129422
27	23	0,38358157	-259,1680461	23	0,183697039	-9069,190283	-21329,37477	-8164,552052
28	24	0,979077562	167,3059681	24	0,448554275	-6373,86433	-16198,14379	-10626,3488
29	25	0,399028462	-251,809036	25	0,171521442	-9232,591306	-25642,96978	-9581,402297
30	26	0,862357176	-5,411245818	26	0,956143628	38,99647872	-12724,90123	2013,833025
31	27	0,982019174	178,7037134	27	0,031720693	-12402,23827	-18340,51154	-2454,658587
32	28	0,003678678	-695,3356635	28	0,238235164	-8408,060517	-20326,68365	-7101,980436
33	29	0,644289676	-137,319357	29	0,154860392	-9468,724185	-21968,122	-22750,81369
34	30	0,753262984	-79,71972397	30	0,950084926	-177,1417875	-13608,15102	-7528,975999
35	31	0,498162897	-205,8424572	31	0,794772035	-3048,893536	-11243,22857	6057,626713
36	32	0,375676039	-262,9677218	32	0,28781261	-7876,694535	-14308,70451	-6022,290063
37	33	0,189650344	-365,8434564	33	0,578392025	-5231,929519	-17575,19889	-16908,50163
38	34	0,625980357	-146,2330329	34	0,199887789	-8862,015405	-18949,48787	-13188,65127
39	35	0,876132537	6,461502926	35	0,173196482	-9209,685106	-23909,49562	-15444,11683
40	36	0,022835093	-570,6045202	36	0,728303335	-3800,888775	-24278,70083	-7665,638436
41	37	0,925213665	58,63293316	37	0,977371171	1067,703582	-1288,88017	12670,44932
42	38	0,160675107	-386,4251555	38	0,403809317	-6772,496741	-20304,99288	-15541,31657
43	39	0,69502882	-111,66906	39	0,187827815	-9015,30092	-25655,80725	-18619,45493
44	40	0,261821508	-321,6719471	40	0,777773179	-3252,765972	-11626,12181	-2500,658703
45	41	0,797316415	-52,77540632	41	0,158321923	-9418,34873	-20532,56096	-10594,13564
46	42	0,047141376	-511,1100235	42	0,196838115	-8900,234059	-23183,74073	-15338,09611
47	43	0,179446695	-372,8484995	43	0,039675338	-12047,47243	-20547,52116	-6054,390204
48	44	0,95336348	102,052776	44	0,837543025	-2485,71041	-16315,73595	-13193,93499
49	45	0,027563915	-555,8661216	45	0,249709554	-8280,330659	-14333,01218	-690,8292414
50	46	0,175605213	-375,5502955	46	0,584770997	-5174,910336	-17570,93389	-7828,780438
51	47	0,668877631	-125,0862556	47	0,545757678	-5521,104565	-13295,28341	-2495,206148
52	48	0,610761709	-153,536407	48	0,171541292	-9232,31903	-12422,21248	1759,158026
53	49	0,616596398	-150,7466792	49	0,994906453	3047,735283	1768,625491	13952,95874
54	50	0,105970511	-433,3615656	50	0,575091441	-5261,359061	-14550,15736	2202,629263
55	51	0,469575836	-218,9653904	51	0,560244115	-5393,196595	-16423,07738	-2299,413952
56	52	0,842149743	-21,44437551	52	0,833076538	-2548,605652	-11587,62619	-1924,387261

average	-6849,059282
min	-32743,75561
max	18766,14015
stdev	7587,018241

distribution

Intervals	Intervals	Frequency
	>-20000	12
-20000	-15000	57
-15000	-10000	105
-10000	-5000	134
-5000	0	106
0	5000	55
5000	10000	20
10000	15000	9
15000	20000	2
		500

Appendix 6: Final synopsis

A Profitable Livelihood Activity? Perspectives of Smallholder Dairy Producers in Kibugu, Kenya.

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I. Introduction

Development in the dairy sector

Dairy production has great importance to the Kenyan livestock sector. Looking at the national level, the dairy sector accounts for 30% of the livestock GDP (FAO, 2011). Through history, the dairy industry has been influenced by shifting political environments, and, focusing on the colonial and postcolonial era, these changes can be subdivided into four phases of policy development for dairy production (FAO, 2011).

Before independence, the dairy market was concentrated around large-scale settler farmers and the possibilities for export. The British policy makers attempted to introduce improved dairy cattle to the production in forms of new breeds of cattle and artificial insemination, but, at the time, these initiatives were confined to the European farmers in Kenya (Conelly, 1998). When Kenya gained its independence in 1963, things started to change, and during the first presidential administration there was a shift towards a smallholder-oriented type of production where the Kenyan farmers were given more opportunities. The government mandated that the Kenya Cooperative Creameries (KCC) should accept all milk despite of its heritage and they introduced a uniform pricing system. This gave room for farmers to secure their share of production through a stable market (Kijima, 2009). Furthermore, it also gave smallholders the possibility to invest in improved cattle and artificial insemination. However, the period of the second administration from 1979-2002 was characterized by corruption and economic instability and this reflected in the dairy industry. The KCC became bankrupt, which resulted in a liberalization of the formal milk market in 1992 and private traders and private processing companies emerged on the market (ibid.). The uncertainty of the formal market led to a rapid growth in the informal sector which is where most of the dairy production figures today (FAO, 2011: Odero-Waitituh, 2017).

Today, the production of dairy is dominated by smallholder dairy farmers, and the structure of the market is made up from various actors in the field (FAO, 2011). More private cooperatives have entered the market and are offering livestock services such as artificial insemination (FAO, 2011). Along with trends of population growth and an increased demand for exports and more produce, Odero-Waitituh (2017) describes the potential for an intensification in the dairy market. This intensification has previously been described to have a positive impact on welfare in rural communities, and, therefore, we will look into the potentials of dairy production in the Kibugu area.

The importance of livestock in Kenya

The value of livestock in Kenya is sensitively attached to tradition, culture, household status and economic stability. In a Kenyan household, the possession of cattle is an asset that provides security, prestige and status. One of the roles of cattle in the dairy production is insurance against life hazard (health, poverty, investment or education). Having a cow acts like an investment in future expected or unexpected plans. Moreover, a cow is considered more stable than the formal financial markets as they function poorly in Kenya and the possibilities of risk management through formal insurance are, in general, absent. Kenyans would then prefer to invest into cattle rather than keeping their savings in a bank account (Awuor, 2003; Ouma et al., 2003). Furthermore, in the frame of the global growing population, Kenya will face a large increase in food demand, in particular in animal source foods such as meat, milk and eggs, amplifying the role of the cattle in food security (FAO, 2017).

Cattle, and especially cows, play an important role in the Kenyan tradition. Hakansson (1994) describes the prestige of having a cow when it comes to relationships. Is it a part of the bride dowry in a marriage, given as a compensation for leaving a kin with another family. In that way, the cow is also used to strengthen kin relationships. The dairy farming is also passed on from generation to generation, splitting up the land for each sibling, which implies a heritage responsibility (Bebe et al., 2002).

Dairy Production Systems

This paper continues to build on the body of work which highlights the low milk productivity of cows in rural Kenya, the high potential for increasing productivity and effecting meaningful change to rural livelihoods. It is estimated that about 80% of the dairy cattle in Kenya are reared and maintained on mixed, crop and livestock, smallholdings where typically 1 to 4 cows are kept on relatively small parcels of land between 1 and 2 hectares (Omore et al., 1998). A majority of these activities are practiced in the fertile central highlands with about 60% of total milk production coming from just 10% of Kenya's total landmass (ibid.). The research of Omore et al (1998) found that the central districts is where 80% of the exotic, crossbred and high-performance dairy cows are found.

The main dairy production systems that exist in Kenya can be broadly defined in three major categories; large-scale intensive, small-scale intensive dairy-manure production and semi-intensive dairy-meat-draught-manure production (Omore et al., 1998).

The management of farming systems can vary greatly from mechanised and intensive production schemes to low input low output subsistence farming. The intention of on-farm consumption or market-oriented sales will largely affect the production systems of farms. Milking of cows is almost exclusively done by hand and completed twice a day in most areas. Farmers will use the manure to fertilise their crops, however knowledge is lacking for proper management practices of this resource and as such leads to inefficient nutrient flows (Omore et al., 1999). Production of milk is heavily influenced by the availability and quality of feed. Most systems consist of stall feeding or zero grazing practices, requiring farmers to supplement all of the nutritional needs of the cow through feeds and cut and carry fodder. Fodder crops such as Napier grass and leucaena are extensively harvested. As population increases, the access and availability of feed resources becomes scarcer, highlighting a severe constraint that farmers face, especially in the dry season. This factor continues to be the major cause of low milk yields in the region (ibid.., 1999).

When trying to ascertain the profitability of dairy production systems in Kibugu a knowledge gap exists. The factors that shape farmers production strategies is not well understood and the interaction between cost benefits and livelihood strategies for dairy producers marks a distortion in our common beliefs of profitability.

II. Research Question

Overall objective:

An assessment of dairy farming intensification as a viable livelihood strategy for farmers in Kibugu.

Research questions and sub-questions:

1. What conditions are influencing dairy production?
    a. What are the demographic structures in dairy production?
    b. How is the marketing of milk achieved?
2. What are the farmers production possibilities?
    a. What assets do the farmers possess?
    b. What do farmers consider advantages and disadvantages in the production?
3. How is the dairy production structured? (classification of production system)
    a. What are the production strategies of the individual farmers?
    b. What does a regular day of production look like?
4. What is the value of dairy production?

a. What are the costs and benefits of dairy production?
b. What are the livelihood outcomes?

III. Conceptual Framework

Sustainable Livelihood Framework

The research questions will form the foundation for a discussion of viability in relation intensification of dairy farming in Kibugu. Through the Sustainable Livelihood Framework (SLF), we seek get an understanding of how different elements are contributing to farmers' decision-making processes and how these elements are related to each other (Scoones, 2015). The framework is based on an assessment of various elements that contribute to a certain way of life. The different elements that this framework is based on cover individual assets, context, institutional and organizational factors, livelihood strategies and livelihood outcomes (Figure 1.).

A Theoretical Framework: The sustainable livelihood framework

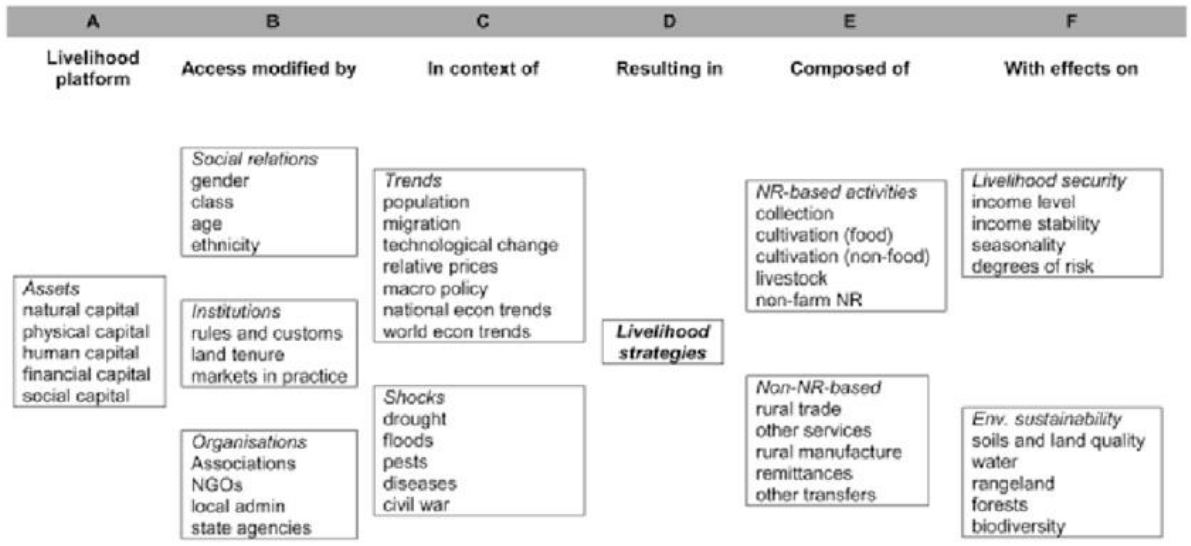

Figure 1. A framework for micro policy analysis of rural livelihoods
Source Ellis (2000)

The assets refer to five different capitals that describe both material and social resources (Scoones, 1998; Ellis, 2000):

- Natural capital: The natural resource stocks such as soil and water, and the environmental services available, pollution sinks for example.

- Economic/financial capital: The capital base which determine the mobility towards any livelihood strategy.
- Physical capital: The equipment farmers possess such as milking tools, milk cooler, barn, vehicle and storage space.
- Human capital: The knowledge, skills, health condition and working ability important in the pursuit of different livelihood strategies.
- Social capital: The social resources that people rely on in the pursuit of different livelihood strategies. This could be social relations, networks and associations that people art part of.

These capitals are modified by institutional and organizational factors that are shaped in a given context. The institutions are defined as "the rules of the game" and represent the structured patterns of behaviour, while organizations are related to "the players" and the processual reasoning behind these structures (Scoones, 1998). Both institutions and organizations are dynamic in the sense that they are ever changing and affected by contextual factors. This could be historical events, the political environment and socio-economic circumstances which are all factors that constrain or enable possibilities for action (ibid., 1998). Different combinations of these inputs shape the pursuit of various livelihood strategies which will eventually result in livelihood outcomes. An outcome could be related to livelihood security or sustainability (Scoones, 2015).

With this framework, we aim to outline the reasoning behind livelihood practices of the dairy farmers and discuss how the pursued strategies makes sense in a bigger picture of development, intensification, and profitability.

Characterization of farm systems

A detailed assessment of the production parameters; herd size, farm size, breeding management, grazing management, milk offtake (liters/cow/year), on-farm consumption (liters/year), marketed milk production (liters/year), will provide a method of classification for the farmers production systems. The production system outlines the farmers practices which will contribute to an overview of the farmers production strategy. Moreover, it will be necessary to separate breeds, namely Zebu and improved breeds, into different classifications. Through an analysis of Omore's et al. (1998) classification system, this paper will aim to incorporate a more detailed assessment and classification of the different smallholder dairy production strategies.

Cost Benefit Analysis

The cost benefit analysis aims to attach tangible values to the livelihood outcomes of farmers, and by ascertaining a monetary foundation of such activities, it will provide a basis for discussion on the profitability of dairy production in Kibugu. The revenue assessed will be the milk price x volume sold, the milk consumed by household, sales of animals (including stock and meat), value of manure input to farming system and offsetting potential of collecting fodder crops. Furthermore, the costs assessed will be covering the labour, veterinary services, water, feed, AI services or bull (reproduction costs), cost of concentrates, cost of milking jelly, cost of calves. That analysis will provide insight into the farmers decision making process and provide an element of comparison with the Sustainable Livelihood Framework.

IV. Methods

Questionnaires

Questionnaires will be elaborated to cumulate quantitative information to settle our starting point, which will help us understand farmer's production capacities. This method is essential to outline the different factors of the dairy production in Kibugu. This will first be done by defining the farm's basic information like the farm size, herd size and feeding system. Moreover, questionnaires will be used to explain the marketing strategy and determine what choice the farmers make with the milk they produce, in which type of market (formal or informal). The expenses and incomes will also be an important part of the questionnaires as it sets the basis of the cost-benefit analysis. We aim to have 30 respondents answering the questionnaires and we will pick farmers that vary in productions strategies.

Participant observation

Through participant observation, we seek to get a better understanding of how the lives of the dairy farmers unfold. Hopefully, we can take part in the everyday conversations and activities of people in the village, observe their daily routines, and build a reciprocal relation (Spradley, 1980). By following the farmers' ordinary ways of managing their milk production, we can gain an insight into the physical setting of the production as well as the social dynamics revolving this labour. Given the short time span of the field work, participant observation can be a good way to quickly build a network and get in contact with potential informants.

Interviews

During the first days of fieldwork we will try to engage in *informal interviews* along with the participant observation. This can be made up from conversations on the road, in the farms or with our host families, and through these informal interviews we can obtain a better grip of what is important on the local level of milk production (Bernard, 2011). As we go on, our network will become bigger and we can start to approach people we think will be relevant to talk to in *semi-structured interviews*. We intend to interview farmers and important stakeholders in the local dairy industry such as the livestock officer and head of the Kibugu dairy community-based organization (CBO). In the first days of the field work, we will prepare question guides for the interviews together with our Kenyan counterparts in order to make our semi-structured interviews uniform. This way, the group members can carry out interviews separately and still be able to maintain a common reference frame for comparing and discussing the given answers (ibid., 2011). This interview guide can also be reviewed through the field work so that we make sure to incorporate new topics or points of interest discovered along the way. By doing this type of interviews, we will get a much more detailed picture of the individual farmer's background and practices related to dairy production. Furthermore, we will also get a deeper understanding of the different assets that make up the farmers' livelihoods which will be useful in our analysis.

Focus groups

We would like to compliment the individual interviews with a *focus group* exercise, in which we will have the participants discussing relevant themes to our research. The focus group will allow us to observe social dynamics among the participants and see how people will react to certain questions in a group setting (Mikkelsen, 2005). We will do a focus group exercise in the end of our fieldwork to have the participants discuss our findings. This way, we will get many people's opinions and use this information together with the answers we will obtain through questionnaires and semi-structured interviews.

Participatory Rural Appraisal (PRA) methods

As a part of the interviews we have considered to use various *PRA methods* to engage the informants directly in our research questions. Regarding the individual farmers, we would like them to outline how they spend their time on a regular day of production. This will be useful in our focus on the structural frame of the production as we will get an insight into how much time and work the farmers put into the dairy production. Through this exercise we

will also see if the farmers are committed to other kinds of agricultural labour. Furthermore, we would like to use PRA methods during the focus group interviews. Here, it would be interesting to discuss perceptions of advantages and disadvantages among the farmers and get them to do a ranking exercise in which they will rank the impact of certain factors to their production. Ranking methods can be used to highlight different interests between different people (Mikkelsen, 2005), and, therefore, we would like to bring farmers with diverse production strategies together in the discussion.

Mapping

With the use of Garmin GPS, a map indicating the location of the different farms that we have collected data on, will be made to provide a visual presentation of the Kibugu area. Other relevant elements can be added as we encounter any new useful information on the field. It will set the scene of our project and help us keeping track of the farms' locations.

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VI. Appendices

Appendix 1) Data matrix

Overall objective: An assessment of dairy production intensification as a viable livelihood strategy for farmers in Kibugu.			
Research questions	Sub-questions	Data required	Methods
What conditions are influencing dairy production?	What are the demographic structures in dairy production? How is the marketing of milk achieved?	Labour utilisation, Individual marketing strategies	Participant observation, Questionnaires
What are the farmers prospects to production possibilities?	What assets do the farmers possess? What do farmers consider advantages and disadvantages in the production?	Positioning of the individual farmer within a socio-economic context Individual understandings of limitations and benefits	Semi-structured interviews PRA - Ranking Questionnaires
How is the dairy production structured? (classification of production system)	What are the production strategies of the individual farmers? What does a regular day of production look like?	Farm size, improved or local breed, herd size, grazing system/feed routine Daily tasks	Questionnaires Participant observation PRA - time use of the farmers GPS Mapping
What is the value of dairy production?	What are the costs and benefits of dairy? production? What are the livelihood outcomes?	Incomes and costs	Questionnaire, formula Semi-structured interviews

Appendix 2) Time schedule

Date	Activities	Persons	Notes
28/2	Meeting with counterparts in Nairobi, Wida Highway Motel	All	
1/3	Travel to Kibugu Grocery shopping Settle with families	All	
2/3	Group meeting within the livestock group Prepare interview guides and questionnaires Transect walk and GPS mapping	Livestock group	Have the methods ready Get an overview of the area and sample population
3/3	Church service (morning) Handing out questionnaire	All	
4/3	Warangi Maathai Day (morning) Interviews with farmers	All	
5/3	Questionnaires	Livestock group	Targeting small producers
6/3	Field trip to large-scale intensive https://www.farmerstrend.co.ke/dairy-farm-tour-11th-august-2018-tujenge-dairy-farm-embu-county/	Livestock group	Insight into bigger farming operations, also interview
7/3	Questionnaires + interview with farmers	Livestock group	Targeting larger farms
8/3	Interview with livestock officer and head of CBO	Livestock group	
9/3	Dinner/party for all students (evening)	All	
10/3	Focus group + PRA exercise (afternoon)	Livestock group	
11/3	Feedback meeting in Kibugu (morning)	All	
12/3	Departure from Kibugu, travel back to Nairobi Lunch and closure of field work at Wangari Maathai Institute, University of Nairobi	All	