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Alternative livelihoods for forest-edge communities: cheese making in the Democratic Republic of the Congo

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International Environmental Studies

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Abstract

This study aims to contribute to the exploration of using innovative ideas when implementing alternative livelihoods. This research examines the possibility for an innovative alternative livelihood for the Nyindu people, a forest-edge community in the Itombwe Mountains, Democratic Republic of the Congo, through the introduction of cheese-making. Cheese making has the potential to avoid livelihood practices that contribute to deforestation.

Having community involvement in this innovative project was central to the analysis of whether this livelihood could be an option. Questionnaires administered to potential consumer and producers elicited results that show a high level of keenness to begin cheese-making and a high level of willingness to purchase locally produced cheese.

Through the use of a questionnaire that was administered for both potential producers (n=132) and consumers (n=100), results show that potential producers are keen to start producing cheese with 95% of respondents communicating their keenness. The main constraint identified to cheese production was cheese making training (92%), followed by access to a financing mechanism (53%). Slightly over half of the respondents state that they bought cheese *occasionally*, followed by about a quarter (24%) stating they bought it *frequently*. The most important attribute when purchasing cheese for most respondents (63%) was *supporting local farmers*.

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Introduction

Tropical forests are an important resource for a plethora of reasons, including providing both ecosystem services and livelihoods. On the wider scale, tropical forests, commonly referred to as “the most species rich ecosystems on earth” (Gentry, 1992), hold a high level of biodiversity while provide services such as climate regulation and carbon sequestering (Cuni-Sanchez et al., 2019). On the more local scale, tropical forests may provide benefits to local communities through providing ecosystem services that provide livelihoods (Tyukavina et al., 2018). However, there are great threats to the future health of tropical forests that may have implications on both the local and global scale.

Deforestation is the cause of approximately 12% of the world’s greenhouse gas emissions and follows just behind fossil fuel combustion in the largest source of carbon dioxide entering the atmosphere (Collatz et al., 2009). Since half of the world’s terrestrial vegetation carbon is stored in tropical forests (Erb et al., 2018), there is therefore a great need for conservation practices to mitigate emissions in these diverse areas. In particular, The Congo Basin, holding the second most area of moist tropical forests in the world, is greatly threatened by deforestation (Tyukavina et al., 2018). Not only is the threat of deforestation in this area a great threat to the longevity of the forests and ability of sequestering carbon, current livelihoods based around the forests are threatened as well. Livelihood practices continue to add to the level of deforestation leading to an increase in poverty, specifically for those living in rural areas that depend on the forests for their income (Tegenge et al., 2016). The high use of ecosystem services in the Congo Basin are increasing the rate of deforestation, such as use of land for agriculture and logging (Tyukavina et al., 2018). 75 million people depend on these ecosystem services and therefore hold importance within economical needs and ecosystem services (Tegenge et al., 2016), and in particular there is a need for an alternative livelihood for the rural poor as the small amount of income they have could be dependent on one of these depleting services.

The need for alternative livelihoods that do not have a negative effect on the forest resources for communities in areas dependent on the surrounding forests is clear. Having alternative livelihood approaches for those living in and depending on areas threatened by deforestation presents an alternative to the destruction of the forest and an opportunity for the rural communities to collect

income from other sources. The drivers of deforestation in the Congo Basin such as increased smallholder land clearing for farming (Tyukavina et al., 2018, slash and burn farming, shifting cultivation, logging and wood energy (e.g. charcoal) (Tegenge et al., 2016) could be avoided with the introduction of an alternative livelihood for the rural poor engaged in such activities. Using the definition of sustainability “meeting the needs of the present without compromising the ability of future generations to meet their own needs” as defined by the United Nations Brundtland Commission (Brundtland Commission, 1987), this alternative livelihood could allow for sustainable livelihood practices. Since the current livelihood practices mentioned are depending on a resource in which the users are continuing exploiting, an alternative livelihood that does not exploit these resources could allow for them to be continually available for future use. Therefore, it is clear that the DRC within the Congo Basin is an area in which more research needs to be done to encourage and explore new livelihood opportunities.

Past and present alternative livelihood projects in the Albertine Rift, a greater area in which the Itombwe mountains are a part of, in general, have somewhat of a reputation presenting the same ideas and using the same practices that have not seemed to have a good success rate (Table 1), such as attempting to create tourism opportunities (Mehta & Katee, 2005; Masozera et al., 2019) or introducing alternative agriculture practices including micro-livestock (Detoef et al., 2018; Didas, 2005). Therefore, it is clear there is a need for a new approach to alternative livelihood projects and conservation interventions.

An innovative entrepreneurial approach, through defining *innovation* as an entrepreneurial approach “which involves the development of new products, new processes, new sources of supply, but also the exploitation of new markets and the development of new ways to organize business” (Santandreu-Mascarell, Garzon & Knorr, 2013), to the development of an alternative livelihood could discover a pathway that could create a link between rural and urban populations through marketing and selling of a product high in demand but also with high cost per unit area. Due to the challenges and associated cost of transporting large volumes of products in remote areas, having a high cost per unit area could allow for this commodity to be sold at a higher rate through reducing the amount of transportation needed. This would not only have the possibility to create income for the rural-poor that are dependent on current unsustainable the diminishing

forests, but it would also help to empower those involved with innovative ideas and expertise to become less dependent on current unsustainable (for the forest) livelihood practices.

The Nyindu people specially, a forest-edge community in the Itombwe mountains, could benefit from an alternative livelihood. This community are agropastoralists dependent on the surrounding forests for many of their livelihoods (Cuni-Sanchez 2019); therefore, at risk of losing livelihoods to deforestation while contributing to the destruction themselves as the Itombwe Mountains face deforestation (for example as explained through smallholder clearing in Tyukavina et al., 2018).

A possibility for a new, innovative, alternative livelihood could be cheese making. This innovative idea has the potential to be of benefit for the communities due to its relevance to the already present culture and interest. Cheese making is respectful of Nyindu culture as it incorporates and makes more use of their already possessed cows. As well, the static nature of this livelihood idea allows for the culture to be maintained in the area already occupied, but as well allows for possible transportation if environmental or societal issues demand it. Therefore, it is not only a livelihood that accounts for the already developed Nyindu culture but it is flexible and able to mould to potential changes that may occur in the future.

This study aims to understand the potential pathway towards cheese making as an alternative livelihood for the rural poor in the Itombwe Mountains through examining both consumer and producer willingness and current practices. At the same time, impacts and potential barriers this alternative livelihood could bring to the Nyindu people will be analyzed. This alternative livelihood has seen to be of success in Masisi, DRC through the production and consumption of Goma cheese (Jullien, 2014; Plovnick, 2015). Goma cheese has empowered the locals both economically and culturally through expertise, nutrition and stability (Jullien, 2014; Plovnick, 2015); through seeing the success in Masisi, this project aims to understand the factors behind the development of a model that would allow for the integration of an alternative livelihood while putting community engagement a top priority.

Research questions

Main question:

1. Could cheese making be an innovative option for an alternative livelihood for forest edge communities in the Itombwe Nature Reserve?

Sub-questions:

2. Are Nyindu people eager and willing to start cheese making for an alternative livelihood? If yes, what are the barriers?

3. Is the urban population of Bukavu keen to buy local cheese?

Study Area

Itombwe mountains

The DRC is the largest country in Sub-Saharan Africa and is one of Africa's most unstable states. Poverty is ubiquitous throughout the country, with approximately 73% of the population living below the international poverty rate of \$1.90USD per day (The World Bank, 2022). Due to the widespread poverty, education challenges, lack of health care access as well as other attributes, DRC was ranked 175 out of 189 countries in the 2020 Human Development Index.

The Itombwe Mountains, located in the South Kivu province of the DRC, are part of the Albertine Afromontane Biodiversity Hotspot and can be considered as one of the most biodiverse regions in Africa (Omari). The Itombwe Nature reserve contains four montane forest types with a plethora of large mammals and bird species including key species (Imani et al., 2021). Annual rainfall in this area has a range of 1200-3000mm per year with variations in climate characteristics at different altitudes (Imani et al., 2021).

The city of Bukavu (Figure 1 & 2) is located on the Eastern border of DRC with a population of more than one million inhabitants and with an elevation of 1 498m (Bisoka, Mudinga & De Herdt, 2021). In the past 25 years, great deal of armed conflicts in the DRC have developed within close boundary of the city; leading to the city being a particularly unstable environment to live in (Bisoka, Mudinga & De Herdt, 2021). Beyond the armed conflicts, Bukavu is over-populated and experiences a great deal of conflict and violence overall (Büscher,

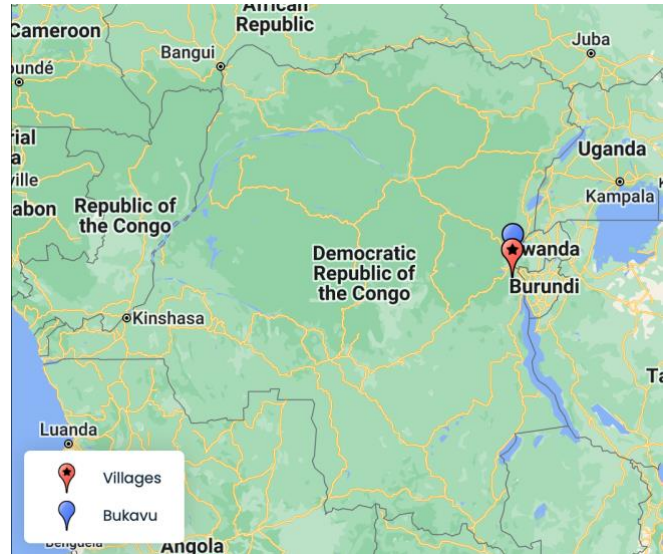


Figure 1: Map of study area in relation to the DRC

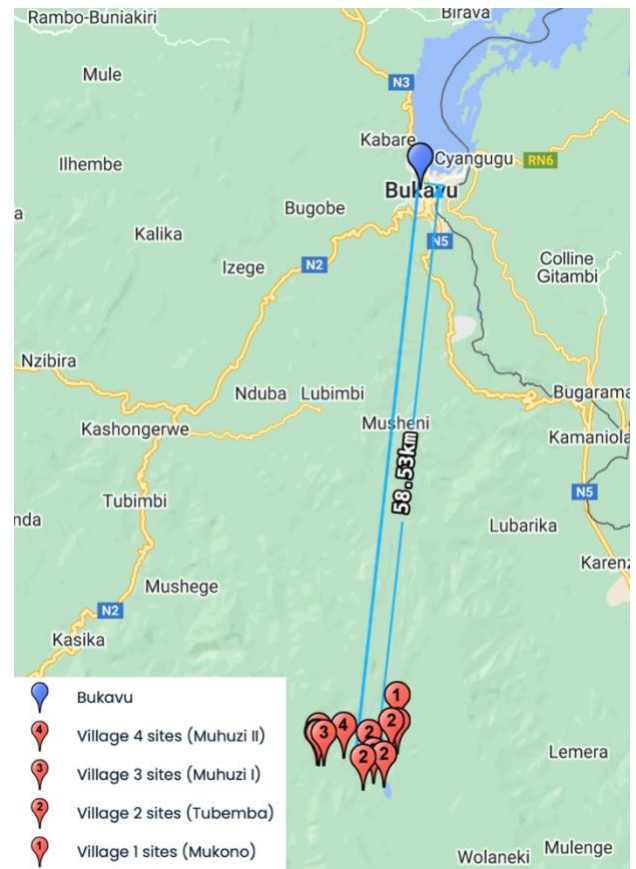


Figure 2: Map of Bukavu and villages

2018; Hoffmann et al., 2019). Equally with the rest of the country, poverty is widespread throughout the city (Bisoka, Mudinga & De Herdt, 2021).

Socio-economic and environmental situation

The northern part of the Itombwe Mountains is home to the Nyindu agro-pastoralists who are dependent on forests for their livelihoods, such as firewood and wild foods (Cuni-Sanchez 2019). The livelihoods in which they depend on can be dependent on ecosystem services provided by the forests. According to Spira et al. (2017), with the opportunity for other livelihood approaches there could be the possibility to incentivize forest-edge communities to participate in other livelihood activities apart from their current practices. These current practices such as charcoal production for additional income has very adverse effects on the environment; including deforestation and loss of biodiversity (Bergen, 2017; Cibemba 2021). Not to mention, illegal charcoal trading in the DRC can be prominent and can lead to disruption of the population's daily lives due to conflict by armed militia (Bergen, 2017; Cibemba 2021). As well, due to the richness in high-value minerals in the mountains, small-scale mining, in which 14-16% of the Congolese population depends on, is not seen as a long-term livelihood while it is also detrimental to the surrounding area such as through deforestation and land degradation (Spira et al., 2017). Bushmeat hunting is also used as a source of income for the Nyindu people, however, it is unsustainably harvested and illegal when done in a protected area while it is a deterrent to wildlife and the livelihood of small-scale mining threatens this livelihood through deforestation and degradation of the surrounding land and water pollution (Spira et al., 2017). Introducing a new, innovative, alternative livelihood approach for the population in these areas could provide not only a new source of income but has the possibility to avoid the engagement in illegal, forest degrading, and unsustainable sources of income.

Literature review

Innovative alternative livelihoods go beyond the typical approaches to introducing livelihoods within communities that have a track record of not working. There are a plethora of different definitions and hierarchies of livelihoods, but all revolve around the central idea that livelihoods are what describes how people live; how they may make their income and how they live their day to day life (Chambers & Conway, 1991). Chambers and Conway have stated: “A livelihood comprises the capabilities, assets (including both material and social resources) and activities for a means of living” (Chambers & Conway, 1991, p. 6). Rural livelihoods in particular usually consist of multiple livelihood components (in this case for example, bushmeat hunting and timber production) (Chambers & Conway, 1991). An alternative livelihood in this case looks to offer alternatives to the climate-degrading livelihoods that are occurring. However, it is important to look at livelihood practices in a local perspective as the world is a diverse place in which one livelihood strategy does not work everywhere. Instead, there is a need for innovative approaches to cater to the needs of local populations through understanding the perspectives of the people and involving them in a participatory way.

A literature search has shown that previous attempts to introduce alternative livelihoods within the Albertine Rift have centered around traditional, non-innovative, methods and strategies. This highlights a need for a more innovative approach that takes into consideration past projects that have not been successful. Therefore, it is important to consider and analyze past projects that have been developed with the goal of introducing new or alternative livelihoods for people in forest-edge communities within the Albertine Rift. This literature review presents a table highlighting the common attributes of past projects and resulting outcomes, therefore developing an overview of the current track record of projects. A more comprehensive summary for some of the projects presented in the table can be found in the appendix (Appendix 1).

This review also works as a basis to understanding the potential benefits upon implementing innovative projects for alternative livelihoods, as previous projects with the same strategies and have been seen to provide the same outcomes. There then stands the potential for innovative projects to break this track record and develop better outcomes for the populations. This work, although focused upon the Albertine Rift, could provide a basis for further exploration in this

region and beyond in respect to the implementation of innovative practices in alternative livelihood projects.

There is a lack of research done on livelihood projects and alternative livelihoods in the Itombwe mountains, and almost no research done on the Nyindu people specifically. These gaps in the research available resulted in a different literature review goal; shifting from focusing solely on past livelihood projects in the Itombwe mountains to looking at past livelihood projects in the Albertine Rift. Literature searches were done on both Google Scholar and The Norwegian University of Life Science's online library *Oria*. Keywords used elicited the lack of research available and an outline of various key words used in the literature search is found in Figure 3, going from the first search *Nyindu Livelihood* to the last search of *Congo Livelihood*. The majority of the projects were found when searching *Itombwe Livelihoods* and *Albertine Rift Livelihoods*, while *Nyindu Livelihoods* mainly just elicited general information and research done on the area. *Panorama: solutions for a healthy planet* website (<https://panorama.solutions/en>) was also used to search for past projects done. There was no research found specifically on the Nyindu people or on the Itombwe Mountains. There was a handful of research done in the Albertine Rift, however, the majority of these projects were not specifically focused upon alternative livelihoods and rather they focused on solely looking at how to conserve the forest, protecting against zoonotic diseases and conflict resolution. The only one project included in this literature review that was found through *Panorama* is "Community-based tourism's contribution towards conservation in Rwanda's Volcanoes National Park" (Bakunzi, 2022).

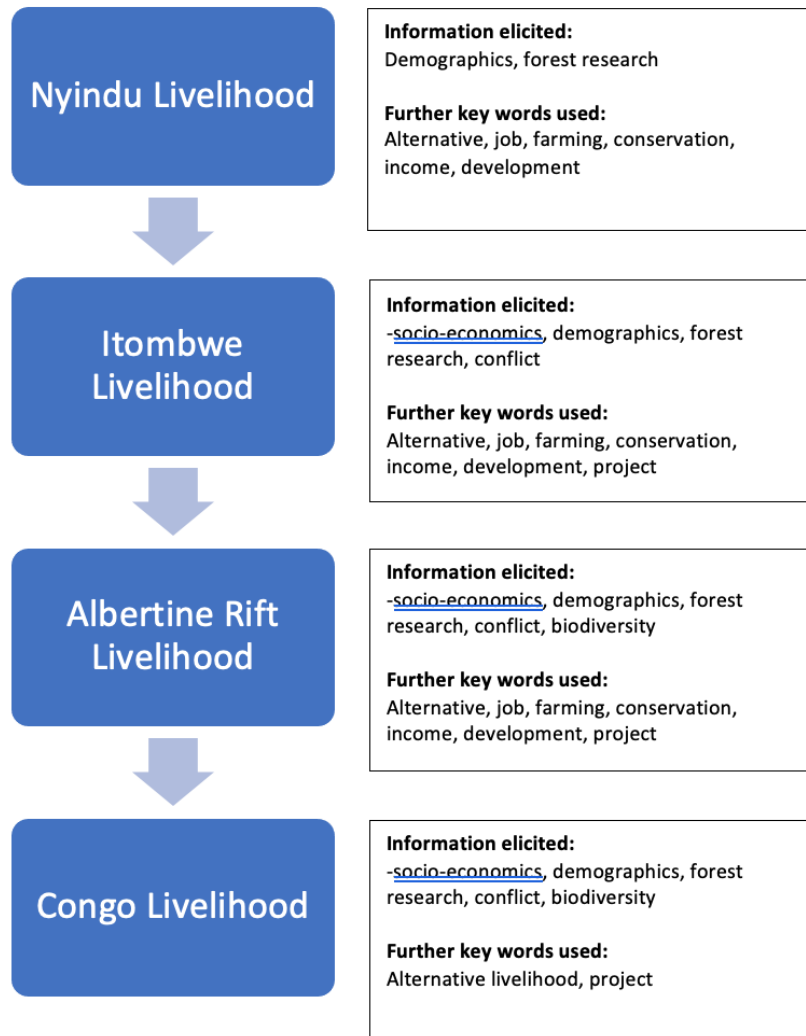


Figure 3: Literature search and key words done in Google Scholar and Oria

Overall, this literature searched showed there is still a small amount of research focused on the Albertine Rift that have documented the strategy towards and the development of projects for improving livelihoods in the region. It is possible that I missed some papers/reports as the search was only done in English. However, through reviewing the handful of projects that there are, one is able to see a pattern emerge. The projects do not show much success in relation to the project's original set goals. It is also possible that some of the success or failures are just not documented to begin with, and therefore this could be understood as a failure to meet its goals. Also, it is difficult to understand the successes of the projects that may not have had clear indicators in the start. It is clear that there is only a handful of strategies in which these projects have undertaken, and there

is a great lack of innovative solutions which just continues the poor track record. Out of the projects that have been published to the public, there seems to be a focus upon four main strategies of improving livelihoods: financial assistance, conservation efforts in terms of the Gorilla populations and overall landscape, tourism opportunities and agriculture practices, or a combination of multiple strategies. Although many of these projects have collaborated with large corporations or non-governmental organizations outside of the DRC (e.g. The International Gorilla Conservation Programme, United States Agency for International Development and the Wildlife Conservation Society) there is still a continued lack of success. *Success* in this sense, would refer to whether or not the project had achieved its set goals according to the original researchers or information available on the community's perception of the project.

Table 1 displays several previous livelihood projects in the region while showing their main strategies and outcomes. The *project focus* refers to the focus the project has displayed in relation to alternative livelihoods. *Community willingness defined* refers to presence of efforts made towards understanding whether or not the targeted community was willing or keen to partake in such alternative livelihood opportunities. *Community engagement goal* refers to whether or not the project had set out a goal to engage the target community in a participatory way in the introduction and implementation of the alternative livelihood. *Specifics of community engagement* refers to whether or not the project has outlined the specific way in which community engagement will be practiced.

Project:	REDD+ ¹	Virunga Massif ²	Kahuzi-Biega Microcred it ³	IGCP Strategic Plan ⁴	Research to Policy ⁵	SW Uganda Beekeeping ⁶	Tuendelee Pamoja II ⁷	Rwanda's Volcanoes National Park ⁸
Location:	Virunga mountain area	Virunga mountain area	Kahuzi-Biega	Virunga Bwindi Landscape	Bwindi Impenetrable Forest National Park	Batwa, Uganda	South Kivu and Tanganyika provinces	Rwanda's Volcanoes National Park
Focus:	“to provide low carbon alternative livelihoods options to the rural communities” (p. 9)	to create unique tourism opportunities through the already unique attractions of the region	use a microcred it scheme (e.g. to raise guinea pigs, make businesses) to reduce poverty that is originally derived from illegal resource use (e.g. poaching, timber collection) , protect gorilla population	“leverage funds and actors for appropriate livelihood strategies” (p. ii) (livelihoods that do not harm the environment)	“improve policy and practice in Integrated Conservation and Development” (p. 19) with a goal of improving livelihoods in the area (e.g. tourism lodges, NGOs)	To train local beekeepers to make honey eligible for markets	Adoption of climate smart agriculture to improve insecurities (e.g. food and income insecurity)	“enabling the local community to be included in the tourism value chain, increase their economic status, thus allowing them to spearhead conservation”
Strategy								
Financial assistance to communities	x		x					
Conservation of wildlife or the environment	x		x	x	x			x
Tourism		x		x				x
Agriculture, micro-livestock	x		x			x	x	

and small-scale farming								
Community willingness/engagement								
Community willingness defined			x		Unknown		Unknown	x
Community engagement goal	x	x		x	x	x	x	x
Specifics to community engagement outlined		x		x	x		x	x
Results								
Still ongoing?	Unknown	Unknown	Unknown	x		Unknown	x	x
Did the project meet its set goals?		Unknown		Unknown	Some	Unknown		x
Funder or organization involved	Wildlife Conservation Society for the Greater Virunga Transboundary Collaboration, Royal Norwegian Embassy in Kampala,	International Gorilla Conservation Programme, United States Agency for International Development, World Wildlife Foundation, African Wildlife Foundation, Fauna & Flora International	United States Agency for International Development, Wildlife Conservation Society, Grauer Gorilla Conservation Project	Conservation International, Fauna & Flora International, World Wildlife Foundation	UK Darwin Initiative, UK Department for International Development, International Institute for Environment and Development Jane Goodall Institute Uganda, Institute for Tropical Forest Conservation, Advocates Coalition for Development and Environment	Community Initiatives for Biodiversity Conservation	United States Agency for International Development, Food for the Hungry	Red Rocks Initiatives for Sustainable Development, Rwanda Development Board, Rwanda Cultural Heritage Academy

Table 1: Literature Review Results

- ¹: Leal, M.E., G. Nangendo & A. Plumptre and T. Evans. (2013).; Pallares, G. (2020).
- ²: Mehta, H. & Katee, C. (2005).
- ³: Detoef, D., Twendilonge, A., Kavuba, F., Cito, R., Radford, N., & Leal, M. (2019).; Handlos, M. (2018).; Darwin Initiative. (2016).
- ⁴: Masozera, A. B., Lawson, C., Liokatis, T., Kayijamahe, C., Makambo, W. & Mbayahi, A. (2019).
- ⁵: Kirkby, A. & Roe, D. (2013).; Darwin Initiative. (2015).
- ⁶: Didas, R. (2005).
- ⁷: Development Food Security Activity (DFSA). (2021).
- ⁸: Bakunzi, G. (2022).

Value Proposition Model

Defining value propositions are one of the building blocks towards developing a business model (Osterwalder & Pigneur, 2010), this model ensures that there is a fitting between the end product and the market. A value proposition model “seeks to solve customer problems and satisfy customer needs with value propositions” (Osterwalder & Pigneur, 2010, p. 16) through describing “the bundle of products and services that create value” (Osterwalder & Pigneur, 2010, p. 22). Through outlining how the product being offered creates value for the customer, elements such as *newness*, *performance*, *price*, and *brand/status* are what can allow for value creation for a customer. A value proposition model takes into consideration customer insights on the available product, this can then inform choices that the business may take in implementation; such as pricing and marketing (Osterwalder & Pigneur, 2010; Osterwalder et al., 2014).

A value proposition model is composed of two main elements: the business’s value proposition and the customer profile. These two elements should fit together in a way that defines value propositions in relation to the customer profile (Osterwalder et al., 2014). Within the business’s value proposition map there is *products and services*, *gain creators* and *pain relievers*. *Products and services* lists the products and services being offered and what the value proposition is built around. *Gain creators* describe how the products that are being offered will create gains to the customer. *Pain relievers* describe how the products and services being offered will be able to ease/relieve customer pains (Osterwalder et al., 2014). Within the customer profile there are *gains*, *pains* and *customer jobs*. *Gains* describes what outcomes that are wished by the customer and the potential benefits they could gain, the gains can be described as required, expected, desired or unexpected. *Pains* describe possible bad outcomes that are related to the segment *customer jobs* these pains can be labeled as undesired, obstacles or risks. *Customer jobs* describes what the customers are trying to get done with this product being offered, these can be functional, social, personal/emotional or supporting jobs (Osterwalder et al., 2014).

A value proposition model is useful in this research as the goal of researching this potential alternative livelihood is to understand whether or not potential producers and consumers are willing and keen to participate. Therefore, it is important to understand how the profile of the potential customer is related to the value propositions that can be provided. In particular, through

understanding *gains*, *pains* and *customer jobs* one is able to understand the steps in which this potential livelihood must be implemented in order to best serve the community. Through administering a questionnaire, this potential business has the ability to cater to the potential customers' needs and desires such as prices willing to pay and preference of type of cheese. This co-creation with the customer creates value in the business (Osterwalder & Pigneur, 2010) while still achieving the economics needed.

Methods and conceptual framework

Conceptual framework

Thematic background

The sustainable livelihood approach takes into consideration aspects of a livelihood beyond income (Krantz, 2001). This approach, originally introduced by the Brundtland Commission on Environment and further developed through the 1992 United Nations Conference on Environment and Development, considers what may limit one's ability to have a livelihood "in an economically, ecologically, and socially sustainable manner" (Krantz, 2001, p. 1). This approach to livelihood development has been adopted by many international aid agencies in order to develop livelihood practices that are resilient to shocks and stresses.

Methodological framework

Research design

This research is a cross-sectional design; combining analysis methods in both a qualitative and quantitative context (Bryman, 2012). Reasoning behind choosing a mixed methods research design is justified in the differences in analysis needs of different questions in the questionnaires being analysed. For example, the need for both qualitative and quantitative analysis when analysing questions regarding challenges producers may face and the steps to overcome. The mixed methods approach will not only consider both qualitative and quantitative analysis techniques as separate approaches, but instead work in unison to help justify the findings that come from both approaches.

This cross-sectional research design uses multiple cases (variation in participants) at one single point in time that will produce quantifiable data that will be able to be analyzed, with the possibility for relationships to occur between variables (Bryman, 2012). This is what Bryman, 2012 defines as cross-sectional design in which data is collected via surveys, questionnaires and/or interviews.

Data collection methods

The sampling technique used in this research is purposive sampling in a qualitative context. This non-probability form of sampling collects samples that are varied in accordance to research goals, overall resulting in samples that are able to be analyzed to have the research questions answered

(Bryman, 2012). Purposive sampling is used in this research in order to generate a sample in a strategic way based on a set criteria; a sample that could be potential consumers and a sample that could be potential producers. This sampling allowed the gathering of participants in accordance with the research goals (Bryman, 2012). This sampling technique is revelatory as the information gathered studies a phenomenon that had not studied before (Bryman, 2012).

Aspects of both convenience sampling and snowball sampling are present which allowed for the sample to include participants that would possibly be missed, although relevant to the research goals, from solely using purposive sampling. Overall, purposive sampling, being a non-probability form, is not able to generalize the sample to the entire population (Bryman, 2012) but in this case of research it is not necessary due to the already small population in this community; it is likely that the sample will be the ones actually participating in the livelihood. This sampling technique has yielded a sample of 232 individuals: 100 cheese consumers in the town of Bukavu and 132 potential cheese producers of the Nyindu ethnic group living in Itombwe mountains.

Data collection in this study was completed using a questionnaire with the assistance of an at-site Congolese technician. Two separate questionnaires were created and used to collect data (Appendix 2 & 4): one for the potential consumers and one for the potential producers.

The questionnaires were originally produced in English but translated into French and Swahili for the participants. This translation was done by two people to ensure accuracy: the Congolese technician and a French-speaking professor. The questionnaires were structured to include closed questions, ranging from *yes* and *no* questions to Likert-scale and multiple-choice questions. Likert-scale questions were provided to gain a better insight into respondents' answers rather than just simply *yes or no* questions while still striving for a high response rate. Some of the questions with partially open-ended answers have been translated into Likert-Scale responses in order to be better analyzed.

The four villages of the Nyindu people that were focused on in this study (Figure 2 and Figure 4) are located approximately 59km from the city of Bukavu with elevation ranging from 2500-2900m. Although there is an approximate distance of 59 km between these two areas (when drawn

in a straight line), there is a major disconnect between the Nyindu population and the main market in Bukavu. This is due to the lack of a road system connecting the two areas, and therefore, one must walk on foot for days, through a ranging elevation and environmental conditions, to reach the market. Figure 1 presents the location of Bukavu and the four villages studied in relation to DRC as a whole.

Producer survey

A semi-structured questionnaire was administered to 132 household heads. These households were residents of 4 different villages in the Itombwe Mountain area in the South Kivu province of the DRC (Figure 2 and 4).

For each household one specific household head (male or female) was chosen to answer the questions in the survey (some questions pertaining to the individual while others to the entire household). This yielded a total of 132 individuals: 96 males (72%) and 36 females (27%). The average age of the participants was 54 years.

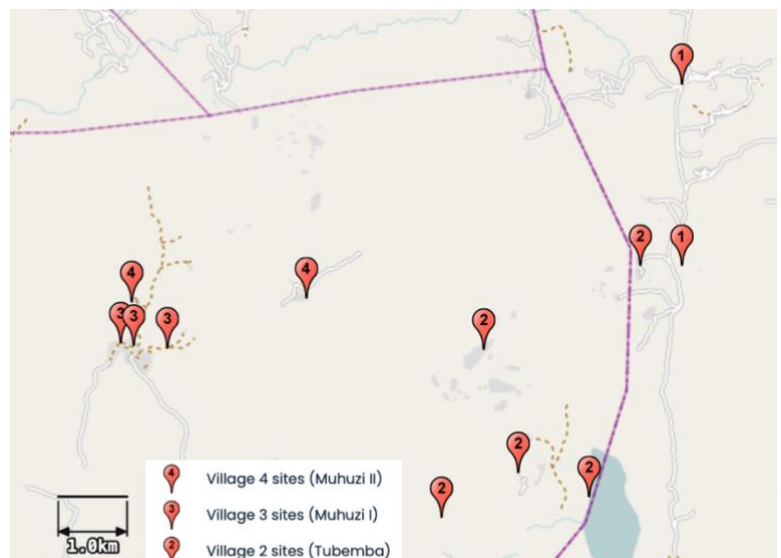


Figure 4: Map of villages

Consumer survey

A semi-structured questionnaire was administered to 100 participants (Appendix 4). There were 66 males (66%) and 34 females (34%) with an average age of 36 years answering the questions for the household. The responses from these participants were gathered at three different supermarkets selling cheese in Bukavu. There was an average of 2.5 adults per household and 2.4 children.

Due to the variety of responses recorded to the question “how often do you buy cheese?”, a Likert-Scale was created to analyze the frequency the participants bought cheese. The following

categories were used: *very frequently* (4 times/week), *frequently* (2-3 times per week), *occasionally* (not weekly but monthly) and *rarely* (only once per year) (Figure 8).

Value Proposition and Awareness Goals

The value proposition for this business model was created with assistance from research done in both the literature review and in the overall study area. This research showed not only the lack of information on the use of cheese in this area, but as well the possible obstacles consumers may have when being a consumer of cheese. For example, research done (through both a literature search and an implemented questionnaire showed the lack of sufficient access to nutrition and access to electrical appliances. This made it obvious that there was a need for the potential consumers to be aware of all the elements to both consuming and storing cheese, as it may be something completely new to them.

The creation of a value proposition for this alternative livelihood project therefore elicited the need for awareness to be at the centre to the potential implementation of the project. Through developing and understanding different *customer pains* in the Customer Profile that the business model creates, awareness goals were used as *pain relivers* in the Business's Value Proposition. These *customer pains* and resulting *pain relivers* are correspond directly to a variety of awareness goals created (Table 2 and Table 3).

Reliability, Validity and replication

The validity of this method could be criticized for its need for the questionnaires to be translated into a language that the Nyindu population are able to understand on an effortless level (Swahili and French). This translation was done by a Congolese technician in order to ensure that the translation would be of precision, however there is always the possibility for information to be translated back in a way that would be bias and/or interpreted in a different way than originally planned.

The replication of this study is high due to the explanation of the different methods used for the data collection, including questionnaires used that are found in Appendix 2 and 3. This would allow for future researchers to gather and analyze data on similar cases or continue the exploration of this certain case. However, the lack of random sampling does not show a representative sample

of the entirety of cheese consumers in Bukavu, since participants chosen were already consumers of cheese. As cheese is fairly expensive in Bukavu, it is not a food product that can be bought by everyone and therefore it would be beneficial to understand the size of the entire cheese consumer population in that city or in nearby cities such as Uvira.

Data analysis

Statistical methods

To begin the process of statistical analysis, descriptive analyses are done in order to develop an overall summary of the data and possibly unveil patterns that were not apparent when looking at the data as a whole. O'Dwyer and Bernauer (2014) state that descriptive analysis is an important starting point for further statistical analysis when looking at raw data as it allows “the researcher and the reader to understand the data before trying to understand what it conveys” (O'Dwyer & Bernauer, 2014, p. 191).

Although descriptive analysis can be sufficient for research projects that are non-experimental and descriptive in nature (O'Dwyer & Bernauer, 2014), due to the purpose of this research including the need for explanation behind the results, other forms of analysis will be done to properly address the research questions presented. Since it is important to be using the sample population as a guide towards what may be fit for the full population, inferential statistics will be take the main role of analysis in this study. Inferential statistics are able to “use the attributes or characteristics measured in a sample (*sample statistics*) to make inferences about the attributes or characteristics in a population (*population parameters*)” (O'Dwyer & Bernauer, 2014, p. 229). Analysis done through descriptive analysis will be used to guide the process of inferential analysis.

Consideration of triangulation needs, validity, trustworthiness

It is important to consider the trustworthiness of data when administering a questionnaire. Although this study has a specific context, it aims to extract data that is able to be transferable to other studies, such as barriers for alternative livelihoods and the ability to develop a pathway towards such livelihoods. Validity and reliability in this study are based on the development of the questionnaire. The questionnaire must consider all aspects relevant to the research questions and be straight-forward with the questions being asked; the researcher needs to ensure conclusions are

not being made that are solely based on the assumptions and values the researcher has brought to the study (Bryman, 2012). Triangulation will be used in this study within and outside of the questionnaire. First of all, when gathering data from the questionnaire; both open and closed questions will be present to elicit data that will be used for qualitative analysis. Second, outside of the questionnaire, there will be research into literature and other sources of data (including grey literature) to elicit other information and compare data from the questionnaire with data that already exists. Triangulation will take place after the main forms of data analysis are completed.

Limitations

Consumer survey

When the consumer survey was administered in a local grocery store in the city of Bukavu, the participants chosen were all already consumers of cheese. This is a limitation on the study as it does not elicit data on the population of people in Bukavu that are keen to purchase cheese. Instead, this only provides information on the population that are already consuming cheese and the habits that they have regarding it. Therefore, the overall population of cheese consumers in Bukavu and surrounding areas remains unknown. Further research should look into the overall population in Bukavu that are keen to consume this locally-produced cheese, whether or not they have tried it before.

There can also be biased representation of data from the consumer survey. As the Congolese technician randomly approach cheese consumers in the grocery store, there is no background information proving that the information given by the participants was true. For example, when asking questions about their cheese-buying habits, one could assume that it is possible some of the participants said a higher amount than they actually buy to show a level of community status that they may wish to have. As well, it may have seemed as though the Congolese technician was hoping for a certain set of answers from the participants. For example, when asked on whether or not supporting local farmers is important to them, it may have seemed more attractive to say yes.

Covid-19 Pandemic and Safety

Due to the Covid-19 pandemic and the overall safety of the region studied, it was not possible for me to travel to the study area. Therefore, all data collection had to be done by someone else. Having

the ability to travel there could have allowed me to get a better idea of the day-to-day life of the Nyindu people and use such information in this research, for example, having the ability to ask follow-up questions in the questionnaires when I felt as though there may be a gap in the data. Lastly, this would have made me feel a stronger relationship to this research.

Replication

This study is very case-specific for the Nyindu people in DRC and in some other places, inside and outside of DRC, it would not be feasible to use this alternative livelihood. Within DRC, even when cows may be present and used for agricultural purposes milk production may not be high enough to pursue this livelihood.

However, there is still the possibility to use the approach of introducing innovative alternative livelihoods in other parts of DRC and the world, regardless of whether or not it involves cheese making.

Epistemological choices and ontological assumptions

One ethical issue that must be considered is the invasion of privacy. Since one of the research questions is focused on how this alternative livelihood will benefit the Nyindu population, it is beneficial to have information regarding the current livelihood practices and the success of them. Therefore, it is important to have anonymity in this aspect of the questionnaire to allow the participants to feel comfortable sharing the truth since this study is focused on benefitting the Nyindu population. For the research questions to be answered there is no need to use names or indicators of who is being spoken about, therefore the aspect of anonymity was taken very seriously.

In large connection with the ethical considerations, the axiology in which this study encompasses is interpretivism. Interpretivism understands that the researcher is unable to escape their own predictions and values that are held to the project (Bryman, 2012). Therefore, in this study, such predictions and values that are held will be both stated and reflected on in the study to be transparent. Reflecting upon this, it must be considered that it is possible for the researcher to be focused only on the benefits of this alternative livelihood and forget about negative effects which may be present. Therefore, it is important to state this bias and use the reflections to build an

analysis that takes into consideration parts of the data that is outside of the researcher's predictions (Bryman, 2012).

This study, influenced by interpretivism, holds the understanding that phenomena can only be studied that are based around experiences of the senses. As Bryman states, this view recognizes that subject matter from "social sciences —people and their institutions—is fundamentally different from that of the natural sciences" (Bryman, 2012, p. 28). Rather than just explaining human behaviour and making predictions around it, this study will focus on understanding the human behaviour and linking that to ways a business pathway could be taken based on the understanding of the people within and around the business pathway (Bryman, 2012).

Results

Producer survey

All respondents owned their primary house, which was always having walls composed of wood, bamboo and mud and their flooring composed of soil (earth). 97% of the houses had their roofs composed of straw, with 3% composed of tolls. 98% of participants grew crops with the average farm size of 1.895 hectares (0.2 to 12 hectares). 98% owned animal(s) in their household. 92% of participants owned cows and 66% owned goats. Out of these participants, the average yield of cow's milk in the dry season is 1.396L and the average yield in the wet season is 2.414L.

No respondents owned neither a television nor motorbike. Less than half (39%) owned a telephone or had solar panels (27%) and 67% had a radio. In the past year, 16% did not have access to a sufficient amount of food in the household. In the past year, the quality of the food in the household was *bad* for over half (64%) of households, *medium* for a quarter (25%), and *good* for 11%. In the past year, 91% of households had access to a sufficient amount of water. The quality of this water was *bad* for the majority (75%), *medium* for 23% and *good* for only 2%.

Most respondents (95.%) were keen to start producing cheese. The main constraint identified to cheese production was *access to cheesemaking training* (92%), followed by *lack of financing mechanism* (53%). Other challenges can be found in Figure 5.

Results from each village separately can be found in Appendix 2.1.

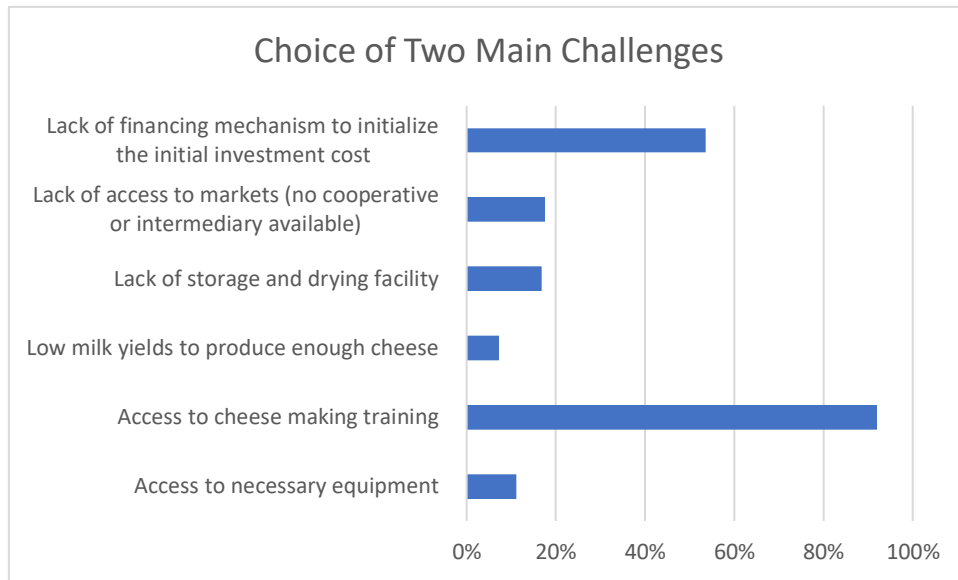


Figure 5: Graph comparing the two main challenges chosen by producers



Figure 6: Photo from potential producer village



Figure 7: Photo from potential producer village

Consumer survey

About half of respondents (53%) states that they bought cheese *occasionally* and about a quarter (24%) bought it *frequently* while 17% bought it *very frequently* and just 6% bought it *rarely*. The most common frequency of buying cheese was 1 time per month by 31 participants followed by 1 time per week by 24 participants (Figure 8).

When buying cheese, on average, participants bought 2.6kg at a time. On average they bought 2.24kg on their last purchase. On these purchases they, on average, paid \$4.18 per kilogram of cheese.

When asked about the type of cheese purchased on the participants' previous purchase, 82 specified on whether the purchase was on soft or hard cheese; 89% purchased hard cheese and 11% purchased soft cheese. The other 18 specified on the type of milk that was used to produce the cheese; 100% of these participants purchased cow cheese.

Most respondents (63%) stated that the most important attribute considered when purchasing cheese was *supporting local farmers*, while 40% considered *type of milk*, 30% considered *price* and 23% considered *soft or hard cheese* (Figure 9).

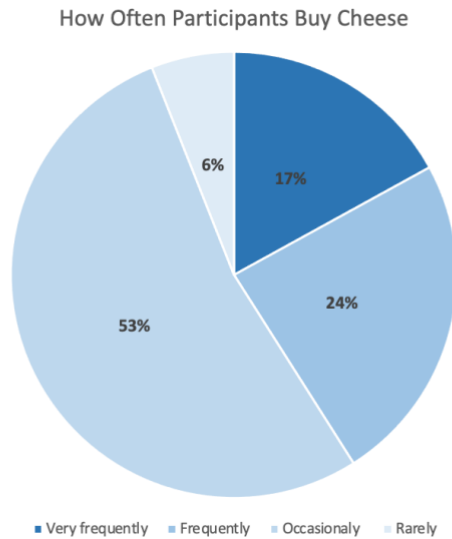


Figure 8: Graph comparing how often participants buy cheese

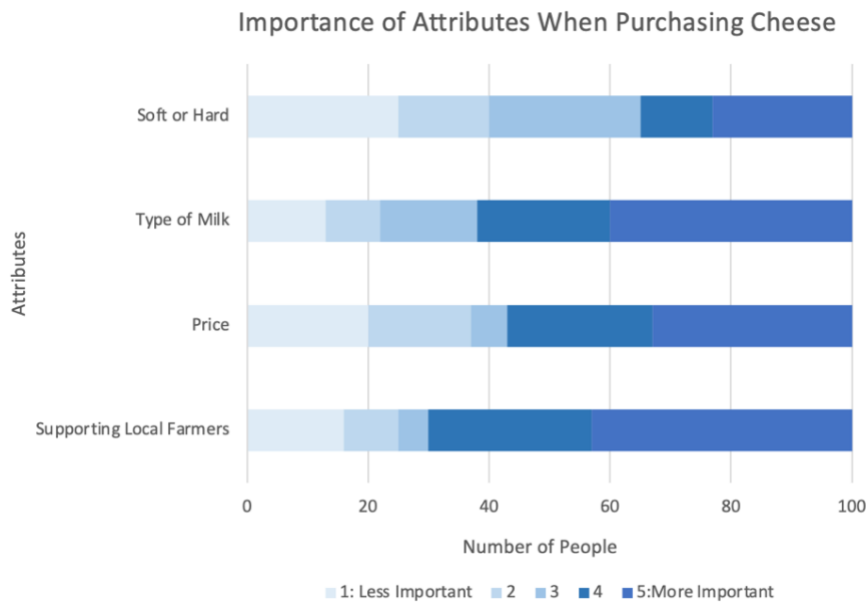


Figure 9: Chart comparing the importance of attributes when purchasing cheese

Value proposition model

The value proposition model I created shows both the business's value proposition and consumer profile for a locally produced and affordable cheese (Figure 10).

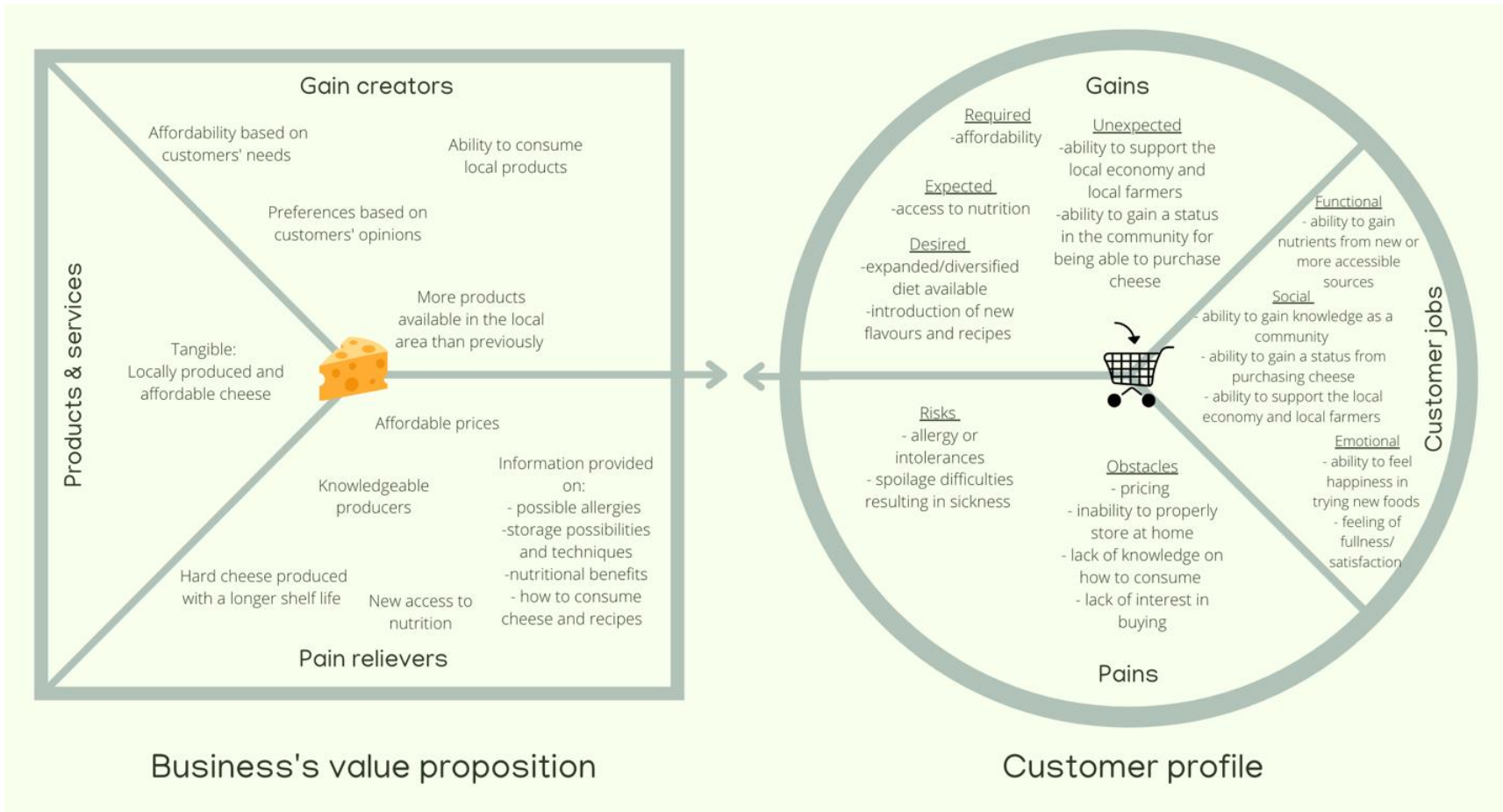


Figure 10: Value Proposition created for locally produced and affordable cheese

Customer Profile

In the *Gains* section attributes are separated into the categories of required, expected, desired and unexpected. The required gains include affordability. Expected gains include access to nutrition. Desired gains include expanded/diversified diet available and the introduction of new flavours and recipes. Unexpected gains include ability to support the local economy and local farmers and the ability to gain a status in the community for being able to purchase cheese.

In the *Pains* section attributes are separated into the categories of obstacles and risks to buying cheese. The obstacle section includes pricing, inability to properly store at home, lack of knowledge on how to consume and lack of interest in buying which could be related to lack of knowledge. The risks section includes allergy or intolerances and spoilage due to storage difficulties that could result in sickness.

In the *Customer Jobs* section attributes are separated into the categories of functional, social and personal/emotional. The functional section includes the ability to gain nutrients from new or more accessible sources. The social section includes the ability to gain knowledge as a community, the status of having cheese and the ability to support local farmers and the local economy. The emotional section includes the ability to feel happiness in trying new foods, the feeling of fullness/satisfaction and the ability to support local farmers.

Business Value Proposition

In the *Products and services* section, the tangible product that shall be offered is described as *locally produced and affordable cheese*.

In the *Gain Creators* section, the following attributes identified were: affordability based on consumers' needs, ability to consume local products, preferences based on customers' opinions and more products available in local area than previously.

In the *Pain Relievers* section (directly related to the *Pains* in the consumer profile), the attributes identified were: affordable prices, knowledgeable producers, providing hard cheese that has a longer shelf life, new access to nutrition and providing information about: possible allergies,

storage possibilities and techniques, nutritional benefits, how to consume cheese and recipes.
These *Pain Relivers* are directly related to the *Pains* in the customer profile.

Discussion

Could cheese making be an innovative option for an alternative livelihood for forest edge communities in the Itombwe Nature Reserve?

Cheese making could be an innovative option for an alternative livelihood for forest edge communities in the Itombwe Nature Reserve. The results elicited from the questionnaires show not only potential producers' willingness to be a part of this innovative livelihood but also show that consumers in Bukavu are keen to purchase locally produced cheese.

Community involvement in the design of an innovative project

As seen from past livelihood projects in the Albertine Rift, there is a lack of information provided on the community involvement of the projects. Community willingness of past projects does not seem to be something the projects have strived to accomplish. Instead, statements such as: "convince households to participate rather than force them" (Leal et al., 2013, p. 24) and "promote interest" (Didas, 2005) have been used to describe the integration of projects into communities' lives rather than doing research to determine whether or not they are keen in the first place.

Having a livelihood project without the understanding of whether or not the community is willing in the first place could, as seen from past projects' attempts, be unsuccessful if its set goals (Table 1). Furthermore, there is a possibility for communities' members to not feel empowered in their own livelihood if they do not feel as though they were involved in the first place. Empowerment and the ownership in their own livelihood projects can be important for not only for a successful implementation of a project but as well as the long and short-term sustainability.

A practical and sensible livelihood project

This potential alternative livelihood is practical and sensible. It is sensible in the way that it is focused around the people that will potentially be a part of it. The livelihood project has intentions of understanding the producers' needs and wants prior to implementation, which can allow for a smoother implementation process. It is practical in the way that it is resources that are already available to them (cattle) and may already have some knowledge upon.

Instead of having hidden objectives, this project's only intentions fall within the benefits of the people, in a two-fold way. First of all, by providing an income and an expanded diet while avoiding deforestation for years to come. By looking beyond just the current benefits, this project has the possibility to provide benefits for years to come as it has the possibility to reduce livelihood practices such as charcoal production that harms the forest.

Implementation possibilities

There are a plethora of beneficial possibilities when this project is implemented.

First of all, there is the possibility to maintain the Nyindu culture. Cuni-Sanchez et al., 2019 showed that Nyindu, and other surrounding ethnic groups, “showed a sense of place attachment to the forest, both in terms of place identity and place dependency” (Cuni-Sanchez et al., 2019). It is therefore important to consider practices that can hold this attachment the Nyindu hold with the forest. By continuing livelihoods that are detrimental to the health of the surrounding forests, the Nyindu people could be at risk for losing this attachment they have.

Next, there is a possibility to ensure that the Nyindu culture is maintained. Particularly the aspects of pastoralism and mobility in the Nyindu culture can be seen in this alternative livelihood project. This livelihood having the potential to be mobile (for example, at the smaller scale, moving the cattle and equipment needed) is important as the aspect of mobility is key in a conflict zone, as the Nyindu people may be forced to move at any time.

Lastly, there are possibilities for implementing this alternative livelihood strategy to other areas. More importantly, understanding the benefits of implementing innovative livelihoods that do not follow the same pattern in which previous projects have is beneficial in helping to change the poor track record of previous projects. There is also an aspect of flexibility present through the possible for an expansion of this livelihood to include other types of cheese such as goat cheese. Since the Nyindu already have goats available to them, the same pathway towards cow cheese making could be possible with goat cheese making. Goat cheese could also help to provide nutrients in different ways while avoiding higher levels of sodium as goat cheese can also contain lower amounts of

sodium than cow cheese (Harvard T.H. Chan School of Public Health, n.d.). However, there would need to be a clear desire for goat cheese, as cow cheese seems preferred now.

Are Nyindu people eager and willing to start cheese making for an alternative livelihood?

If yes, what are the barriers?

The Nyindu people show a high level of eager and willingness to start cheese making for an alternative livelihood (95%).

Barriers

Access to training was the most dominant challenge (92% of participants), it is clear that providing training should be one of the most thorough and foremost steps in the potential introduction of this livelihood. The second most chosen barrier, *lack of financing mechanism* (chosen by 53.6% of participants), must also be considered and therefore some sort of financing mechanism must be provided to potential producers, considering that some equipment will be needed to start the process. One option for this could be to create a cooperative so that the equipment is shared amongst the producers and not everyone must buy their own. This would also encourage the producers to learn from one another and facilitate marketing and trade.

Possible vulnerabilities

When, or if, this alternative livelihood becomes implemented within the community there are a number of vulnerabilities that may be present to the producers as the production size grows.

First of all, considering the fact that there is already an issue of agropastoral conflict, such as cow stealing (Verweijen & Brabant, 2017), in the area in which producers would be present there is the possible vulnerability for the producers to experience loss of their primary resource for cheese production. Especially if the business grew a great amount in size and the profitability was high, there could be more incentive for cow-stealers to target the facilities. Therefore, one must consider how high the incentives actually are for producers to start participating in this alternative livelihood. Whether or not the possible vulnerabilities can be avoided is important to understand prior to the implementation.

Next, due to past and present conflict in the area there are vulnerabilities surrounding the sustainability of this livelihood. Apart from cow-stealing, there is also the possibility for facilities to be ruined in conflict or for cows that the producers depend on to be injured/killed. This might not be a problem in the near future as the peace situation hopefully improves, as the mobility of the small-scale facilities and equipment along with the cows helps to curb this challenge.

Is the urban population of Bukavu keen to buy local cheese?

The urban population of Bukavu already consuming cheese seems to be keen to buy local cheese, as 63% of participants interviewed labelled it as the most important attribute. As was mentioned above, the people that were interviewed were already purchasers of cheese and therefore we were unable to determine how many people buy cheese in the total population of Bukavu – but we do know this is not a staple product and price can make it expensive for the average citizen. Therefore, greater awareness may be needed for urban citizens. The results from the questionnaire show a high percentage of individuals that consider supporting local farmers an important attribute when purchasing cheese, with 63% of participants labeling it as the most important attribute.

Building awareness for both consumers and producers

Multiple awareness goals have been created (by myself) for both producers and consumers. These goals are presented in the two tables: *Producers’ awareness goals* (Table 2) and *Consumers’ awareness goals* (Table 3).

Producers’ awareness goals

Awareness goal	How to provide awareness
To be aware of the price	Understanding why a high price per weight is beneficial in the transportation of cheese
To be aware of the benefits of introducing a locally produced cheese	Understanding the opportunities that will be available to the consumers and their possible benefits
To be aware of potential spoilage	Understanding different techniques of proper storage of cheese with and without a refrigerator Understanding proper packaging techniques and proper sanitation to avoid contamination

To be aware of the access to cheese making training	Understanding that there will be access to cheese making training available for those who need it (related to information on packing and spoilage)
To be aware of financing mechanisms	Understanding that financing mechanisms that are needed to start the production journey can be offered

Table 2: Producer awareness goals as derived from the Value Proposition model

Consumers’ awareness goals

Awareness goal	How to provide awareness
To be aware of the price	Provide information on the expected prices of the cheese and the reasoning behind such prices - linked to the benefits that can be gained from purchasing cheese (nutritional value)
To be aware of various ways to integrate cheese into a diet	Understanding the ways to consume cheese through providing multiple recipes that include cheese with other food that is already available
To be aware of the value of integrating cheese into a diet	Provide information on the nutritional value of consuming cheese through educating on the essential nutrients present in cheese and their roles they play in the human body
To be aware of the possible spoilage issues	Provide information on the techniques behind proper storage of cheese with and without a refrigerator
To be aware of possible allergies/intolerances	Provide information on the potential to be allergic to the product, how one knows they are allergic, and what they can do in case of an allergic reaction Possibility for sample tasting

Table 3: Consumer awareness goals as derived from the value proposition model

Following the creation of these two tables, two brochures have been created as a potential way to present the awareness goals to the producers and consumers (Appendix 5). These brochures could be handed out at various places potential consumers could be such as the supermarket, farmer’s markets or sampling stations. The education being provided to communities for this awareness could be done in a variety of ways other than solely the distribution of brochures, especially considering the fact that a great number of the producer respondents were illiterate. For example, expert/producer-led seminars could enhance awareness and understanding while oral presentations including theatre and musical performances could allow for the inclusion of those who are illiterate. But overall, it is important to keep in mind that the consumption of cheese is very much dependent on consumer and producer awareness of the benefits and uses of the product. The following section will focus on consumers’ and producers’ awareness goals separately with a more

in-depth insight on the steps needed to be taken for these goals to be implemented and why the awareness is important.

Consumers

A value proposition created for this study (Figure 10) elicited the need for a structured approach to bringing awareness to the community, in particular non-cheese consumers, in the event that this alternative livelihood is implemented. As cheese is not currently a common part of the Congolese diet, it is important to consider the possible unfamiliarity and lack of knowledge about the purchasing and use/consumption of cheese. Therefore the Tables 2 and 3 have been created based upon these value propositions.

These awareness goals should be considered as one of the steps for implementation of this livelihood. This table was created with a focus upon the pains elicited in the consumer profile of the developed value proposition model (Figure 10). The potential customer pains in the category of risks accounted for in this awareness-raising include: allergy or intolerance and spoilage. In the category of obstacles, pains included in this awareness-raising include: high prices, inability to store at home (related to spoilage), lack of consumption knowledge (including both knowledge on how to consume and the resulting nutritional benefits of doing so). Using this model to bring awareness to potential consumers and producers can be related to the pain relievers category in the value proposition. Although these awareness goals have focused upon a few of the value propositions, there could be the possibility for other awareness goals to arise during the implementation of the project, as one cannot be fully aware of all of the possible obstacles that may arise.

It is important for communities to be aware of various ways to integrate cheese into a diet since cheese is not already a common food in DRC. It is important for potential consumers to understand how they are able to consume it; both in its raw and cooked form. This education can be given through a package of recipes given to consumers upon purchase or when bringing awareness to the communities (as shown in Appendix 5). It is crucial that these recipes contain ingredients that are already available to the people and the only ingredient that is not already a staple in their lives

is cheese. There should also be a variety of recipes available for the consumers to ensure a variation of preferences and dietary restrictions are accounted for.

To be aware of the value of integrating cheese into a diet, the consumers should be educated about the nutritional benefits. Cheese contains a plethora of nutritional benefits that may not be easily available otherwise. This nutrient-dense food is a source of, for example: calcium, protein, Vitamin B12 and Vitamin A (Harvard T.H. Chan School of Public Health, n.d.). These nutrients are considered to be a part of the six essential nutrients in which the World Health Organization (WHO) has deemed crucial for supporting a healthy lifestyle (WHO & FAO, 2004; Harvard T.H. Chan School of Public Health, n.d.). Some benefits of these essential nutrients that could be used as a way to educate the communities on the nutritional value of consuming cheese are shown in Appendix 5.

Overall, as the WHO and FAO states, it is important to have a possibility for diversity within a diet for those who may not have access to a sufficient amount of nutrients: “It is essential to create strategies which promote and facilitate dietary diversification in order to achieve complementarity of cereal- or tuber-based diets with foods rich in micronutrients in populations with limited financial resources or access to food.” (WHO & FAO, 2004, p. 327), introducing cheese at a nutritional resource could provide this for the communities.

To be aware of the possible spoilage issues it is important to educate the consumers and on different practices that avoid spoilage. With the consideration of the variation in storage facilities available to potential consumers, there is a need for understanding how to store the cheese at home with and without the access to a refrigerator or freezer. Providing this awareness can help to avoid illness related to spoiling. Consumers should also be educated on identifying when cheese has become spoiled. In general, to ensure a long shelf-life of cheese proper packaging and temperature control is important (Jalilzadeh, Tuncturk & Hesari, 2015). It is therefore up to both the producers and consumers to ensure this.

Being aware of the possibility for allergies and intolerances to the consumption of cheese is important for the consumer’s safety, specifically the possibility of a dairy allergy or lactose intolerance. Symptoms that consumers should be aware of are found in Appendix 5. Consumers

should also be aware of proper management techniques if faced with an allergy or intolerance, such as limiting their dairy intake or seeking medical help if it is needed. However, it is possible that many potential consumers may already know whether or not they can consume cheese due to either past consumption of cheese or other dairy products.

Producers

A table (Figure 10) has been created that elicits the possible similar pains consumers may experience in the view of producers. As well, awareness from the main obstacles that the producers had stated in the questionnaire have been included as well.

In particular for producers it is important for there to be awareness on the benefits of having a product that is a high-price per weight. This ensures that the disconnection from the market, due to lack of roads and transportation, still allows for producers to transport their product in an easy and profitable way. For consumers, being aware of the price is also related to other elements of awareness. For example, if consumers are turned away by a higher price than they originally planned to pay, there is the possibility to convince consumers into purchasing due to the nutritional benefits it can bring them.

For producers, understanding the techniques that can allow for longer shelf life can allow for an ability to have a more diversified customer-base due to the varying storage facilities consumers may or may not have. Longer shelf life, for example, can be achieved by differing packaging techniques and avoiding contamination. Packaging techniques such as plastic and wax coatings can protect the cheese from spoilage. Having a packaging technique that is created by materials already available would be of great benefit to the producers and consumers. For example, the use of beeswax was shown to cause “a significant reduction in mold growth after 4 four ripening months” (Nájera et al., 2021, p. 22) and therefore extended the shelf-life. Beeswax has also been seen to extended shelf-life of cheese for several years (Jalilzadeh, Tuncturk, & Hesari, 2015). Furthermore, contamination of cheese during the production process can also be avoided with help from proper packing techniques, but it is also important for there to be a sanitary production process. Using control methods to ensure there is no cross-contamination and microorganism growth on the surface of the cheese after packaging has occurred can help reduce the rate of spoilage (Nájera et al., 2021).

Future work

It is the hope that this project will contribute towards the implementation of cheese making as an alternative livelihood for the Nyindu people. This research has shown that this will not only benefit the Nyindu people and the surrounding forests but also the consumers of the cheese through new opportunities that may not have been available before. Making an attempt at production may be the best way to see whether or not this project will actually be successful for this area. Also, further understanding of the true population of cheese consumers in Bukavu, as well as the true population of those who would potentially become consumers, is needed through more research. Introducing cheese to the locals (done through e.g. free sample tasting at a market) that have not tried it before could be a great way to understand the population that could be consumers.

Other urban markets could also be considered in this project, such in in Uvira Bujumbura (Burundi) or Kigali (Rwanda), where Goma cheese (from North Kivu in DRC) is already traded. This could expand the business and potentially allow for more producers to have this as an alternative livelihood, furthering the avoidance of livelihood practices that harm the forests.

Conclusion

This project investigated the possibilities for implementing innovative alternative livelihoods into communities that have previously been constrained in livelihood possibilities that are detrimental for the environment. Results indicate that the Nyindu people of the Itombwe Mountains are keen to take part in cheesemaking. As well, potential consumers of cheese in the town of Bukavu find that purchasing cheese that is produced locally is important to them. Therefore, there seems to be room for such project. Future work should focus on addressing the constraints to cheesemaking identified by producers, while also increasing awareness of the benefits of locally produced cheese for non-cheese consumers of Bukavu town.

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Appendix

1. Literature review

Following the table (Table 1) highlighting the common attributes of past projects and resulting outcomes, a more comprehensive literature review outlines the attributes for some of the past projects.

First of all, financial assistance-based alternative livelihood projects have included incentive packages and microcredits. The *Greater Virunga Transboundary REDD+ Action Plan (2013)* project based in the Greater Virunga Landscape was an attempt to “provide low carbon alternative livelihood options to the rural communities” (Leal et al., 2013, p. 9). In this case, in the Greater Virunga Landscape, REDD+ recognizes illegal timber harvesting and charcoal production and farming that continues to put high human pressure on natural resources. These alternative livelihood options were created for conservation needs and the potential accelerate the removal of greenhouse gas emissions and stop forest degradation. This project was based around an incentive package, called Reduced Emissions from Deforestation and Forest Degradation (REDD+). This incentive package would reward emission reductions into “tradable carbon credits” or could be paid for by public funds directly. REDD+ also emphasizes the community and biodiversity benefits that should be created throughout this incentive package scheme. There was no specific way in which community willingness was defined in this project, and instead, REDD+ has mentioned that there is a need to convince households into participating in their ideas (Leal et al., 2013, p. 24). However, it was mentioned that “a community approach needs to be taken to present and implement the incentive package” (Leal et al., 2013, p. 23) and there is a need for the context to be taken into account to properly tailor the project to the locals. REDD+ lists multiple ways in which the incentive package would work: conservation farming, forest friendly cash crop, transition from charcoal, family planning, microfinancing, and beekeeping to name a few. There is very little description on the overall implementation approach to each of these possibilities and instead there is only description upon the overall community consent of the project as well as organization of the project as a whole. Following the publication of this action plan in 2013, there is not much accessible information or updates on the success of this program. However, there is statements upon this project not being successful due to a few project and area-related issues including: weak coordination, conflict, lack of financial resources and political issues (Pallares,

2020). In conclusion it is stated that there is a need for more data and this action plan is only a first step and a dialogue should be started thereafter (Leal et al., 2013; Pallares, 2020).

The Kahuzi-Biega Case Study: Microcredit as a solution to reduce poverty and illegal resource use in protected areas (2019) was a project in the Kahuzi-Biega national park with intentions to use a microcredit scheme to reduce poverty that is originally derived from illegal resource use, with the combined effort to protect the gorilla population (Detoef et al., 2019). Beneficiaries were given loans to be used to create alternative livelihoods and microenterprises that would work in a cycle, allowing beneficiaries to have a sustainable source of finance for their alternative livelihoods. One alternative livelihood that was focused upon was guinea pig farming. This was created to help provide a protein source while reducing bushmeat hunting. Community willingness was stated to be present in this project, however there little information how this willingness was discussed and the only community engagement goal presented was to have collaboration with community associations. In regards to the success, this project states that although microcredit could be a good solution to illegal activities, there needs to be a more integrated approach that focuses on multiple threats that this area is facing. There was even a recorded increase in some illegal activities during this project (particularly deforestation) and it is not believed that this project can stand alone to reduce poverty to the extent it is needed (Detoef et al., 2019).

The Guide for community animal health workers: Raising rabbits and guinea pigs (cavies) for meat in smallholder environments in the Democratic Republic of the Congo (2018) is a guide designed for the implementation of micro-livestock of rabbits and guinea pigs. This was believed to be a quick and easily achievable solution to food and income security in the region by providing a source of protein. The guide presents aspects regarding the keeping of rabbits and guinea pigs; from which species to choose to how to slaughter and cook them. The guide tries to encourage the population to participate in micro-livestock practices by describing rabbits and guinea pigs as “delicious, tasty, healthy and highly nutritional meat containing a lot of protein” (p. 1) and making comparisons to other widely used livestock while stressing the great benefits of rabbits and guinea pigs.

Next, conservation strategies have focused on the conservation of both wildlife (namely gorillas) and the environment in general. These strategies have also used money incentives for the

community to participate. The IGCP strategic plan (Masozera et al., 2019) is an ongoing plan that has the goal to “leverage funds and actors for appropriate livelihood strategies” to help protect gorillas. This conservation-based project with tourism aspects included. This project presents a strong outline for community engagement and specifics on how that shall occur. One of the main strategies *community engagement focused on civil society strengthening and mitigating human wildlife conflict* works to ensure there is inclusive decision making as well as the integration of community based planning and monitoring. As this project is still ongoing, there is a lack of information on the progress and possible successes. This project has also included an *exit strategy* in which the goal is to ensure there is a self-sustaining programme as a result.

Mapping great ape conservation projects with a livelihood component in DRC: a preliminary study (2016) (Kasereka et al., 2016) is a report that has mapped out different conservation efforts that include livelihood aspects while analyzing the impacts they have made. This project is not included in the table (Figure 5) due to the vast amount of projects within the paper. This report realizes the negative attitudes many locals have on conservation and the lack of funds being provided. As well, it is stated that there is a lack of information being provided for the impacts of poverty alleviation on conservation areas and the inability to analyze whether benefits continued past the conclusion of different projects. This creates a lack of knowledge upon which strategies work and ways in which other projects can be improved.

This report has stressed the importance of understanding the well-being of the locals and taking their ideas and knowledge into consideration for future and ongoing projects. As well, it is stated that there is a need to include market and non-market-based incentives for the communities to understand and practice conservation, which could improve the current negative view. Livelihood security is also noted due to its importance for economic security. Overall, this view to combine conservation with livelihood practices could be a way in which a win-win situation could occur for both the environment and the society. But, there is a need for projects to take a bigger approach at data collection for the analysis of benefits, for example, household incomes before and after the project.

The project *Research to Policy: Conservation Through Poverty Alleviation* (Kirkby & Roe, 2013), located in the Bwindi Impenetrable Forest National Park, was a project aimed to “improve policy

and practice in Integrated Conservation and Development” (Kirkby & Roe, 2013, p. 19) with a goal of improving livelihoods in the area and ensuring the areas are protected for such livelihoods. There was a goal for community engagement in this program, stating that engagement was a key strategy for the management of national parks (Kirkby & Roe, 2013, p. 5). There was some documented success with this project, however, there was an inequality in the way in which the successes were received by the locals. Overall, wealthier households benefitted more from this project.

Furthermore, tourism strategies have used the unique landscape and wildlife of this region to develop projects that could create income for the communities. There is a particular trend of using the area’s gorilla population to stimulate tourism activities. The *Virunga Massif Sustainable Tourism Development Plan* (2005) project based in the Virunga Massif Region was developed in order to create *unique* tourism opportunities through the already unique attractions of the region; going beyond just including the habitats of gorillas (Mehta & Katee, 2005). This plan was created in the context of an internationally growing tourism industry that Africa should benefit from and in the summary, this project states that “communities in the Virunga Massif region do see the parks and tourism as one of the contributing factors of poverty alleviation” (Mehta & Katee, 2005, p. 9). This was presented as a framework for a way to provide “additional economic and environmental benefits to local, national and regional stakeholders” (p. 9) through the collaboration of the three countries within the region (DRC, Rwanda and Uganda). There was a focus upon the conservation of both culture of the region and the environment while having maximum participation of the community within the development of the framework, hoping to bring great benefits to local communities. The methodology behind the building of this plan included document research, field visits and stakeholder meetings, ending in a workshop and design charette. This methodology is said to have been used in order to take a participatory planning approach so that there was as much local involvement as possible. This plan goes into great detail of the present (2005) state of the communities as well as different possible itinerary plans and tourism attractions that could be of benefit. There is a lack of information on the community willingness to participate in this program, even though there is a great amount of detail regarding the ways in which the community will participate in the planning and implementation. It is unknown whether or not this project is ongoing as well as whether or not it has been successful.

Finally, agriculture strategies have focused mainly upon micro-livestock. *Beekeeping project in SW Uganda* (2005) summarizes a report on beekeeping in South-Western Uganda using the Kanungu Apicultural Information Services (KAIS) project to train locals. In this area, there is a lack of education, apart from traditional methods that do not meet the quality standard, for making honey eligible for international markets and although there is a great demand in the market as well, there is a struggle to find markets to export honey to. KAIS's goal is to both conserve biodiversity in the area while creating a livelihood that is economically viable. Their mission is to train beekeepers that are able to, in turn, share their knowledge with others. Community willingness was not defined in this project, and instead it was stated that there was a need to promote community interest in the project. There are a few specifics to community engagement outlined, such as using indigenous beekeeping knowledge, but there is not much information on how this will actually be implemented. The original goals of this project were not met due to lack of funds. Although there is a lack of information available on the current status of this project, KAIS has stated that they will continue to work towards their goal even with a lack of funds.

The *Tuendelele Panoja II* project, located in South Kivu and Tanganyika provinces, had goals from increasing food and income security to overall health and safety in South Kivu and Tanganyika provinces from 2016-2021. In order to do this, this project wished to adopt *climate-smart* agriculture. Due to the lack of information able to be found on the original project, community willingness is unknown. However, it does seem that there is an overall community engagement goal and specifics on how this has been done have been outlined. In a report published in 2021, it is stated that there has been success with implementation and field visits but issues arose regarding financial literacy and having accessible small loans (Development Food Security Activity, 2021, p. 41).

It is clear that, even with many successes, there is a track record of great failure in projects aiming at alternative livelihoods within the Albertine Rift. There is a continuing trend of similar projects that, with the same goals, largely use the same strategies each time.

In order for these communities to prosper and have access to successful livelihoods that are needed, another approach must be taken. This approach should not continue the same path in which

previous projects have but instead take a more innovative approach that includes the population at every step of the process. An innovative approach, such as cheese making, could be the breakthrough in which these populations desperately need.

2. Producer survey

Socio-demographic questions

1. Gender
2. Age
3. Do you own your primary house?
4. What is your main house's roof material?
5. What is your main house's wall material?
6. What is your main house's flooring material?
7. If you grow crops, what is the size of your farm in hectares?
8. If you have animals, which ones and how many?
 - a. Cow
 - b. Goat
9. Cow's milk in the dry season (litre per day per cow)
10. Cow's milk in the rainy season (litre per day per cow)
11. Over the past year, did you have a sufficient amount of food in the household?
 - a. What was the quality of the food?
12. Over the past year, did you have a sufficient amount of water in the household?
 - a. What was the quality of the water?
13. Do you own:
 - a. Radio
 - b. Telephone
 - c. Solar panels
 - d. Television
 - e. Motorbike

Cheese making

1. Interested in cheese making? (yes/no)
2. What are the main constraints for you to begin cheese production?
 - a. Access to necessary equipment
 - b. Access to cheese making training
 - c. Low milk yields to produce enough cheese
 - d. Lack of storage and drying facility
 - e. Lack of access to markets (no cooperative or intermediary available)
 - f. Lack of financing mechanism to initialize the initial investment cost

2.1 Producer survey results

	All villages	Village #1	Village #2	Village #3	Village #4
Number of participants	132	20	44	32	36
Socio-Demographic questions					
1. Gender	73% male 27% female	80% male 20% female	75% male 25% female	65% male 35% female	72% male 28% female
2. Age	54.15	55.6	48.68	59.09	55.63
3. Own your primary house?	100% yes	100% yes	100% yes	100% yes	100% yes
4. House roof material	97% straw, 3% tolls	100% straw	100% straw	100% straw	97.3% straw 2.7% tolls
5. House wall material	100% wood, bamboo, mud	100% wood, bamboo, mud	100% wood, bamboo, mud	100% wood, bamboo, mud	100% wood, bamboo, mud
6. House floor material	100% soil	100% soil	100% soil	100% soil	100% soil
7. Grow crops?	98%	90%	100%	100%	100%
8. Own animals?					
a. Cows	91.67% Average: 6.35 cows	75% Average: 7.2 cows	93% Average: 6.36 cows	93% Average: 5.8 cows	97% Average: 35 cows
b. Goats	66%	65%	68%	60%	64%
9. Cow's milk dry season (L/ per day per cow) (average)	1.39L	1.05L	1.6 L	1.25L	1.42L
10. Cow's milk rainy season (L/per day per cow) (average)	2.41L	1.78L	2.67L	2.16L	2.6L
11. Sufficient amount of food?	Yes: 84%				
a. Quality of food	Bad: 64% Medium: 25% Good: 11%				
12. Sufficient amount of water?	Yes: 91%				
b. Quality of water	Bad: 75%				

	Medium: 23% Good: 2%				
13. Own:					
a. Radio	67%				
b. Telephone	39%				
c. Solar panels	27%				
d. Television	0%				
e. Motorbike	0%				
Cheese making					
1. Interested in cheese making?	95.45%	95%	97.73%	96.88%	91.67%

Overall challenges chosen (all villages):					
Access to necessary equipment	access to cheese making training	low milk yields to produce	lack of storage and drying facility	lack of access to markets	lack of financing mechanism
11.2%	92%	7.2%	16.8%	17.6%	53.6%

3. Consumer survey

Socio-demographic questions

1. Gender
2. Age
3. How many adults live in the household?
4. How many children live in the household?

Current consumption behavior

1. How often do you buy cheese? (more than once per week, once per week, less than once per week but more than once per month, once per month, less than once per month, but more than once per year, once per year, less than once per year, never).
2. When you buy cheese, on average, how much do you buy (in kg)?
3. Think back to the last time you bought cheese:
 - a. How much did you buy?
 - b. How much did you pay?
 - c. Which type of cheese was it? (soft/hard/type of milk)
4. To what extent are the following important to you when making your cheese-purchasing choices? (1: less important, 5: more important)
 - a. Soft or hard
 - b. Type of milk
 - c. Price
 - d. Supporting the local farmers

4. Study area


Village name	Site name	Coordinates	Altitude
Mukono	Mukono (village 1, site 1)	S02°50'13.4" E028°49'35.3"	2931m
Mukono	Kabembe (village 1, site 2)	S03°00'38.6" E028°49'35.6"	2886m
Tubemba	Tubemba/Kisuru (village 2, site 1)	S03°02'04.6" E028°49'15.9"	2857m
Tubemba	Tubemba (village 2, site 2)	S03°02'44.6" E028°48'01.5"	2798m
Tubemba	Tubemba (village 2, site 3)	S03°04'04.6" E028°47'41.4"	2748m
Tubemba	Tubemba/Binyenge (village 2, site 4)	S03°03'43.1" E028°48'17.8"	2905m
Tubemba	Lac Lungwe (village 2, site 5)	S03°03'54.6" E028°48'51.6"	2772m
Muhuza I	Muhuza I (village 3, site 1)	S03°02'43.9" E028°45'30.9"	2417m
Muhuza I	Rivière Nakijabulwa (village 3, site 2)	S03°02'41.3" E028°45'08.9"	2376m
Muhuza I	Rivière Muhembeji (village 3, site 3)	S03°02'42.7" E028°45'14.9"	2383m
Muhuza II	Muhuza II (village 4, site 1)	S03°02'22.0" E028°45'14.1"	2449m
Muhuza II	Muhuza II (village 4, site 2)	S03°02'20.1" E028°46'37.0"	2820m

5. Awareness Brochures

5.1 Consumer Brochure (to be translated into French and Swahili)

Locally produced and affordable cheese

AN AWARENESS GUIDE FOR CONSUMERS



A bit about the project

Cheese-making has the potential to be a beneficial livelihood for forest-edge communities. After the gathering of data through questionnaires we have learned some information on the preferences of consumers as well as the needs of producers. Our main goal is to provide an alternative livelihood to the forest-edge communities of the Itombwe Mountains that can both boost local economy while helping to avoid the practice of environmentally-degrading livelihoods.

Jalilzadeh, Tunçtürk & Hesari. (2015).
Jones, A. (2020).
WebMD & DerSarkissian, C. (2021).
WHO & FAO. (2004).
Harvard T.H. Chan School of Public Health, n.d.
Nájera et al. (2021).

Health Benefits

CHEESE IS A GREAT SOURCE OF:

Calcium: has a job in many of the body's metabolic process and supports bone health

Protein: plays an important role in the growth and development for muscles, bones, skin and hair

Vitamin B12: important for both the functioning and further development of the brain

Vitamin A: needed for functioning of the visual system and growth and development

Storage and spoilage

STORAGE TECHNIQUES

With refrigeration:

- opened cheese can typically be stored for 3-4 weeks.
- wrapping the cheese in some sort of plastic or cloth covering can also reduce the possibility of the cheese becoming hard.
- unopened cheese can be stored for a much longer period, producers should provide more specific information

Without refrigeration:

- cool and dark places can help reduce spoilage

TIPS ON SPOILAGE

When is cheese spoiled?

- (there is the possibility to discard the part of the cheese that is spoiled and continue to consume the rest of the product in some circumstances)
- a slimy surface
 - visible mold

The cheese being produced will be pasteurized, this will help with potential spoilage issues.

General awareness

PRICING

Pricing of the cheese is based upon multiple factors:

- price of production
- price of storage prior to purchase

The goal is to have a price that is consumer-friendly and allows for the ability of all types of household incomes to afford

ALLERGIES AND INTOLERANCE

Similar to other foods, there is the potential for allergies and intolerances to cheese products.

Common intolerance/allergy symptoms:

- rashes, nausea, bloating, diarrhea, swelling

What to do in case of an intolerance/allergy reaction:

- limit or avoid intake
- seek medical attention if severe reaction occurs

WHY BUY LOCAL CHEESE?



You can support your local economy



You can support local farmers



You have the ability to enhance your diet with new flavours



You can gain great nutritional benefits



You can try something new!

Ways to integrate cheese into your diet

GENERAL CONSUMPTION

Cheese can be consumed without the need for preparation or cooking. Simply, eat the cheese alone for either a snack or a side dish of a meal. Cheese can also be added to any meal dependent on the preference of the consumer (such as Fufu).

CHEESE AND POTATOES

Many varieties of potatoes can have an enhanced flavour with the addition of cheese. Simply melt the cheese onto the potato of choice or eat it raw on the top.

CHEESE AND CHICKEN

Adding cheese to your chicken recipes can enhance the flavour, A simple chicken recipe with garlic tastes great with added melted cheese on top or stuffed into the chicken breasts.

CHEESE ON BREAD

Cheese on bread is a staple in many countries. Adding a slice of cheese on bread is a great meal or snack for anytime of the day. Adding cheese on crackers is also an option.

5.2 Producer Brochure (to be translated into French and Swahili)



Locally produced and affordable cheese

AN AWARENESS GUIDE FOR PRODUCERS



A bit about the project

Cheese-making has the potential to be a beneficial livelihood for forest-edge communities. After the gathering of data through questionnaires we have learned some information on the preferences of consumers as well as the needs of producers. Our main goal is to provide an alternative livelihood to the forest-edge communities of the Itombwe Mountains that can both boost local economy while helping to avoid the practice of environmentally-degrading livelihoods.

International Dairy Foods Association. (2022).
Jalilzadeh, Tunçtürk & Hesari. (2015).
Nájera et al. (2021).

Benefits of producing cheese locally

BENEFITS FOR YOU

Cheese production can not only bring in a source of income for producers but it also has the ability to enhance one's skills in marketing and production in general. Production of a product that can benefit the local community can also develop a sense of pride.

BENEFITS FOR THE CONSUMER

Having a locally produced cheese will bring benefits to consumers through benefits to their health, building a sense of community and being able to enhance the local economy.

Packaging Techniques

Having packaging techniques that allow for longer shelf-life of cheese can diversify your consumer-base due to the varying access to at-home storage facilities.

Beeswax coatings: can reduce mold growth and extend shelf-life for some cheeses up to several years

CONTAMINATION

Avoiding the risk of contamination through a sanitary production process can reduce the rate of spoilage. Micro-organism growth on the cheese can hinder the shelf-life, therefore it is important to consider temperature control and proper packaging.

PRICING

Cheese is a product that has a high-price per weight. This is beneficial as there is the ability to transport a high price value of product with lower weight. Therefore, more value can be transported with a smaller effort than other foods.

PASTURISING

Pasteurization of milk is a process that applies heat to milk (a certain temperature is applied to the milk for a certain amount of time, for example 71C for at least 15 seconds)

Using pasteurized milk for the production of cheese can have the following benefits:

- a safer milk quality, for example, through avoiding the growth of potentially harmful microbes
- can avoid potential spoilage due to microorganisms and enzymes
- there can be consistency in the cheese that you produce

WHY SHOULD CONSUMERS BUY LOCAL CHEESE?



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