

The role of religion – and culture at large – in affecting food systems is still underemphasized in economic literature. Religion and food are unmistakably intertwined and the way food systems operate, is – among other factors – influenced by the local religious context.

This doctoral dissertation explores how the milk system in Ethiopia has evolved within a diverse and long-standing religious setting. We disentangle this general objective in three different research questions, that each address another element of the milk system, and we study how religion influences milk consumption, milk production, and milk transactions. On the one hand, we investigate how Orthodox fasting rituals – that require abstinence from animal-sourced foods – impact dairy demand and supply. Orthodox Christians are the largest religious community in Ethiopia who observe multiple official fasting periods covering roughly half of the year. On the other hand, we study if the religious identity of buyers and sellers impacts milk transactions and trading preferences. We provide evidence that collective fasting rituals impact consumption and purchase decisions not only of the practicing Orthodox households, but also of other religious groups in the country and especially in dominantly Orthodox localities. Furthermore, sharing religious ties seems to be important for a sub-set of producers and consumers when selecting exchange partners. To improve the potential of the Ethiopian dairy sector, interventions are needed to smoothen the effect of seasonal demand swings so that returns to investments in the sector increase.

The devil is in the detail
Disclosing the impact of religion on the milk system in Ethiopia

Eline D'Haene

2020

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on the milk system in Ethiopia



The devil is in the detail –

“Details of a matter are its most tricky or problematic aspect”, Oxford dictionary of idioms

– An idiom conveying the idea that details are important and likely to cause problems when not properly accounted for. But, while it may seem simple at first sight to account for these details, the details are complicated and it takes time and effort to include them.

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**The devil is in the detail:
Disclosing the impact of religion on the milk
system in Ethiopia**

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for the degree of Doctor (PhD) in Bioscience Engineering: Socioeconomics

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Persoonlijke reflectie

Dit is het dan. Mijn doctoraatsboekje. Voorzien van een mooie kaft, geïllustreerd door een goede vriendin. Wat een traject. In plaats van een traditioneel bedankingswoordje, heb ik ervoor gekozen om in deze sectie even stil te staan bij de voorbije vijf jaar. Mijn ups and downs, mijn leercurve, mijn avontuur. En wat voor één.

Het begon allemaal in april 2015, op het einde van mijn masteropleiding. Een opstartend VLIR project in Ethiopië en twee professoren die potentieel in me zagen. We schreven een doctoraatsproject uit en dienden dit in voor funding. In augustus kwam het verlossende telefoontje. Eline, proficiat, je mag aan je PhD avontuur beginnen. Euforisch was ik, roepen, springen, gillen. Ongeloof, mag ik werkelijk beginnen? Ik?

De eerste oktober 2015 was het zover. Mijn eerste stappen in het doctoraatsleven. Ik voelde me groot, slim, erkend. Niet veel later kreeg ik last van de eerste PhD symptomen: onzekerheid en twijfel. Hoe begin je aan een vierjarig PhD traject? Wat zijn de tussenstappen in dit vierjarig proces? Gelukkig kon ik voldoende afleiding vinden. Ik volgde een aantal vakken, workshops en trainingen, en bovenal, ik kreeg steun uit onverwachte hoek: twee senior PhDs die me elk bij een stuk van mijn doctoraat geholpen hebben: mijn eerste vragenlijst en dataverzameling alsook mijn eerste paper. Plots was alle twijfel weg en voelde ik me deel van een enthousiast team.

Eens gelanceerd liep alles van een leien dakje. Wat leuk dit doctoraatsleven. Tijdens een zomerschool in Corsica had ik het geluk een nieuwe promotor te leren kennen die met veel enthousiasme inpikte op mijn doctoraat. Na een tijdje miste ik toch interactie en afwisseling. Toen de assistent binnen onze onderzoeksgroep wegging, zag ik dus mijn kans schoon. Ik stelde me kandidaat en alweer was godin Fortuna me goed gezind. Zo komt het dat ik een jaar later niet alleen PhD onderzoeker was maar ook academisch assistent. Dit deel is me enorm bevallen. De interactie met studenten, deel uitmaken van hun leertraject, en hen stelselmatig zien groeien en ontplooien. In de tussentijd schreef ik verder aan mijn doctoraat met een gepassioneerde bureau-genoot die mijn ideale sparringspartner bleek te zijn. Ik lanceerde een tweede veldwerkronde, diende mijn eerste paper in, en schreef mijn tweede paper. Geïntregeerd door verschillende initiatieven rondom mij, sloot ik me aan bij een aantal werkgroepen. Leerrijk en enthousiasmerend. Ik vond de drive die ik nodig had om de nodige stappen te zetten in mijn doctoraat.

Het ging allemaal vliegensvlug. Plots had ik twee gepubliceerde papers en een doctoraatsboekje. Wel plots is relatief. Achteraf lijkt alles eenmaal 'simpel'. De afgelopen maanden heb ik alles op alles gezet. En dat was best pittig, maar zeker de moeite waard.

Ik heb de afgelopen vijf jaar enorm veel geleerd, en dan vooral over mezelf. Je ziet jezelf evolueren tijdens zo'n traject en ik ben trots op mijn metamorfose. Ik heb zoveel vrijheid gekregen van mijn beide promotoren om mijn eigen weg te zoeken. Nieuwe dingen uitproberen en het vertrouwen van hen krijgen dat je dit tot een goed eind zal brengen. Dat bleek voor mij de succes-combinatie.

Wel, dit is het dan. Ik ben klaar voor nieuwe avonturen om verder te ontdekken en te leren. Ik heb er ongelooflijk veel goesting in, so let's do this!

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List of abbreviations

AGP-LMDP	Agricultural Growth Project - Livestock Market Development Program
ASF	Animal-sourced food
CSA	Central Statistical Agency of Ethiopia
DCE	Discrete choice experiment
EA	Enumeration area
EDRI	Ethiopian Development Research Institute
ETB	Ethiopian ETB
FAO	Food and Agriculture Organization of the United Nations
FSP	Food service provider
HLPE	High Level Panel of Experts on Food Security and Nutrition
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
ILRI	International Livestock Research Institute
kg	kilogram
L	litre
LC	Latent Class logit model
LIVES	Livestock and Irrigation Value Chains for Ethiopian Smallholders
LSMS	Living Standard Measurement Survey
OECD	Organisation for Economic Co-operation and Development
OLS	Ordinary Least Square
RP	Random Parameter logit model
SD	Standard deviation
SE	Standard error
SME	Small and medium enterprise
SNNP	Southern Nations, Nationalities and Peoples Region
SSA	sub-Saharan Africa
SURE	Seemingly Unrelated Regression Equations
USD	United States Dollar
USAID	United States Agency for International Development

Summary

Food systems are rapidly transforming in developing countries due to changing diets and rapid urbanization. Diets get more diversified with a higher inclusion of non-staples – especially processed and animal-sourced foods – and households become increasingly dependent on purchased produce rather than home-produced food [1]. Still, the contribution of animal-sourced foods to total protein intake remains limited in low-income countries, their contribution is only 20% [2]. Annual growth rates of per capita milk, meat, and egg consumption in sub-Saharan Africa have been stagnant to slightly negative over the past decades [3] and per capita calorie availability of animal-sourced foods is projected to decrease in the region by nearly 5% in the coming decade [2].

These trends have very often been attributed to a supply chain that could not keep pace with an increasing demand for animal-sourced foods. In this dissertation, we argue that factors influencing demand for animal-sourced foods could still suppress the intake of animal protein, even when animal-sourced foods are available and affordable. We specifically focus on the influence of religion given the explicit association between religious beliefs and practices, and animal-sourced foods. Food instructions laid out by various religious groups often constrain or even completely prohibit consumption of (specific) animal-sourced foods. Because religion changes food choices and food intake, it is expected to alter the food system at large [4].

The role of religion in affecting food choices and food supply is, however, underemphasized in economic literature [5], while it is believed that the impact of religion on food systems will remain important given the growing share of religious people worldwide, and especially in sub-Saharan Africa. There is a need for case-by-case studies that investigate how food systems have evolved within particular religious settings.

In this dissertation, we explore how the milk system in Ethiopia has evolved within a diverse and long-standing religious context. We study the impact of religion on the cow milk system, as milk is the most important animal protein source in Ethiopian diets. Despite the large stock of cattle in the country, milk is not regularly consumed because it is a luxury product. When it is consumed, it is mainly intended for children or other vulnerable population groups (such as elderly and pregnant or lactating women) [6, 7]. Yearly milk intake in the country reaches only 20.6 kg per adult equivalent [8], which is only half of the sub-Saharan African average [9] and less than one-fifth of the required intake for healthy diets [10]. Problems of structural supply, poorly developed local markets, low purchasing power, and lack of consumer awareness regarding the nutritional benefits of animal-sourced foods have been advanced to explain low consumption levels [11-14]. Less explored is how religion could possibly curtail the demand and supply of milk in the country. Ethiopia hosts a large group of Orthodox Christians, representing 44% of the total population [15]. Ethiopian Orthodox Christians abstain from animal-sourced foods during multiple fasting periods that cover roughly half of the year [8, 16, 17]. Fasting practices cause significant milk demand seasonality in the country,

which in turn influences milk production, processing, and marketing practices. It seems that the practice of fasting affects milk consumption in two ways. First, consumption is directly affected by fasting as Orthodox members are not allowed to consume milk and other animal-sourced foods during fasting periods. Second, fasting might impact the availability and pricing of milk due to lower investments in the sector and broader value chain effects. The widely occurring fasting practices in the country thus possibly contribute to the underdevelopment of the country's dairy sector compared to other countries in the region (such as for example Uganda or Kenya) [13, 18]. Few authors, however, have looked at these issues.

To explore how the milk system in Ethiopia has evolved within a diverse and long-standing religious context, we focus on three different research questions, that each address another element of the milk system, and we study how religion influences milk consumption, milk production, and milk transactions. We provide answers to these research questions in five chapters.

In a first chapter (which corresponds to Chapter 3), we investigate how the presence of a religious fasting period influences household milk intake in the country. We find that Orthodox fasting impacts milk intake and sourcing strategies of consumed milk, and that these effects are not limited to the Orthodox community. Fasting not only reduces milk intake of Orthodox consumers, it also reduces the availability of milk, especially in dominantly Orthodox areas, thereby also impacting milk consumption of non-Orthodox households adversely.

The second and third chapter (i.e. Chapter 4 and 5) explore how milk producers have adapted to the demand seasonality caused by Orthodox fasting practices in two different major milk production areas, so called milk sheds, hosting an Orthodox majority: the Great Addis milk shed and Mekelle city. We find that milk producing households are affected twice by fasting practices. First, these households, which are predominantly or exclusively Orthodox Christian (which is the situation in respectively Great Addis and Mekelle), lower their own intake of milk during fasting which creates excess milk at the household level. And second, as market opportunities dwindle during fasting, there are fewer outlets available for this excess milk. To cope with this excess milk, farmers adopt different strategies so as to bridge fasting periods: (1) some farmers – especially those with reduced or limited market access – reduce the total production of milk at the farm by aligning the number of cows in milk with fasting periods and/or by feeding lower quality diets to the cows, (2) others increasingly channel produced milk to their youngest children, (3) nearly all producers expand their milk processing activities, and (4) those households with good market access and market arrangements – usually those located close to or in major cities – are able to continue milk sales to some extent during fasting periods. We also find that the widespread traditional home-processing performed within the households seems to be mainly a consumption stabilizing rather than a sales stabilizing strategy as sales of processed milk products barely go up after the fasting periods.

Having shown that religious fasting rituals undeniably impact both milk consumption and production in the country, we wondered if religion – which is part of one's social identity – would influence with whom people preferentially trade milk. We therefore investigated if sharing religious ties facilitate milk transactions for both consumers, who purchase milk from the market (Chapter 6), and producers, who sell milk on the market (Chapter 7). Evidence of ethnic market segmentation has been reported in Africa [19, 20], but insufficient attention has been paid to the occurrence of religious market segmentation. We find that an important subset of the consumers we interviewed consider the religious affiliation of potential milk sellers when deciding from whom they would like to buy milk. These consumers show preferences for co-religious sellers and are willing to pay more and walk further to buy milk from these co-religious sellers. Producers on average do not deliberately discriminate among potential milk buyers based on their religious background, yet we observe significant preference heterogeneity. This implies that while some producers have less or no preference for the religious background of potential buyers, others display have strong preferences. Further research is needed to investigate the presence of religious preferences both from a buyer- and seller-side but are findings evidence that religious segmentation might be at stake in the Ethiopian milk market.

This dissertation concludes that Orthodox fasting practices undeniably impact milk consumption and production in the country, thereby creating considerable market inefficiencies, since markets largely dissolve during long Orthodox fasting events especially in dominantly Orthodox settings. Furthermore, we find evidence of coordination problems along religious lines. To improve the potential of the Ethiopian dairy sector, interventions are needed to smoothen the effect of seasonal demand swings and possibly increase returns to investments in the sector. To achieve this, further efforts are needed towards supporting farmers, enhancing processing practices, ensuring greater availability of chilling centres for storage, as well as improving market access and transportation facilities to assure market integration and to allow marketing to areas where fasting is less prevalent. Furthermore, investing in school milk programmes could be an effective way to increase milk consumption of children, while such programmes simultaneously allow to establish a guaranteed milk market outlet during fasting since children are exempt from fasting participation. Finally, nutrition awareness creation is needed to raise the intake of milk in the country but also to alter social norms that force vulnerable population groups to engage in fasting practices since this has been shown to have negative repercussions for nutritional and health outcomes.

Samenvatting

Voedselsystemen veranderen in een ijltempo in ontwikkelingslanden door veranderende voedingspatronen, maar ook door een snel urbanisatieproces. Voedingspatronen worden steeds gediversifieerder en bevatten meer en meer verwerkte en dierlijke producten. Huishoudens produceren bovendien steeds minder van hun voedsel zelf, maar kopen in toenemende mate producten aan op de markt [1]. Ondanks deze trends, blijft het aandeel van dierlijke producten in de totale eiwitopname beperkt in lage-inkomenslanden – het aandeel bedraagt slechts 20% [2]. De jaarlijkse groei in per capita consumptie van melk, vlees, en eieren in sub-Sahara Afrika stagneert en is zelfs lichtjes negatief de laatste jaren [3]. Ook voorspelt men dat de per capita caloriebeschikbaarheid van dierlijke producten zal afnemen in de regio met ongeveer 5% in de komende tien jaar [2].

Deze trends worden vaak toegeschreven aan aanvoerketens die niet in staat zijn te voorzien in de toenemende vraag naar dierlijke producten. In dit doctoraatsonderzoek, argumenteren we dat zelfs wanneer dierlijke producten beschikbaar en toegankelijk zijn, hun inname kan beperkt worden door factoren die de vraag naar dierlijke producten beïnvloeden. We focussen in het bijzonder op de invloed van religie aangezien er expliciete associaties zijn tussen enerzijds religieuze overtuigingen en rituelen, en anderzijds dierlijke producten. Verschillende religieuze groepen leggen voedingsinstructies op aan hun geloofsgenoten en deze beperken of verbieden de consumptie van (specifieke) dierlijke producten. Omdat religie een grote invloed heeft op voedingskeuzes en voedselinname, wordt er verwacht dat religie ook het voedselsysteem wijzigt [4].

De rol die religie speelt in het vormen van voedselkeuzes en de voedselaanvoer is echter onderbelicht in de economische literatuur [5]. Nochtans zal de impact van religie op voedselsystemen groot blijven aangezien het aandeel gelovigen wereldwijd blijft stijgen, vooral in sub-Sahara Afrika. Er is nood aan case-by-case studies om te bestuderen hoe voedselsystemen zich ontwikkeld hebben binnen specifieke religieuze middens.

In dit doctoraat onderzoeken we hoe het melksysteem in Ethiopië zich heeft ontwikkeld binnen een diverse en sinds oudsher bestaande religieuze context. We bestuderen de impact van religie op het koeienmelksysteem, gezien melk het belangrijkste en meest geconsumeerde dierlijke product is in Ethiopië. Ondanks de grote veestapel in het land, wordt melk niet regelmatig geconsumeerd omdat het een luxeproduct is. Als het geconsumeerd wordt, wordt het vooral gegeven aan kinderen en andere kwetsbare groepen (zoals ouderen, zwangere vrouwen, of vrouwen die borstvoeding geven) [6, 7]. Melkconsumptie in Ethiopië bedraagt slecht 20.6 kg per volwassenequivalent per jaar, daar waar het gemiddelde in sub-Sahara Afrika dubbel zo groot is [8]. Richtlijnen voor gezonde voeding bevelen innames aan die minstens 4.4 keer zo groot zijn dan de huidige inname [10]. Structurele problemen met aanvoer, slecht ontwikkelde lokale markten, lage aankoopkracht, en beperkte kennis en bewustzijn omtrent de nutritionele voordelen van dierlijke producten worden vaak naar voren

geschoven om de lage innames te verklaren [11-14]. Wat minder bestudeerd is, is hoe religie de vraag en het aanbod van melk beperkt in Ethiopië. De Ethiopische bevolking bestaat uit een grote groep van Orthodoxe Christenen en er wordt geschat dat deze groep 44% van de bevolking vertegenwoordigt. Ethiopische Orthodoxe Christenen consumeren geen dierlijke producten gedurende verschillende vastenperiodes doorheen het jaar. Deze vastenperiodes beslaan ongeveer de helft van een jaar [8, 16, 17]. De vastenpraktijken veroorzaken significante vraagschommeling, wat natuurlijk de melkproductie, melkverwerking alsook het vermarkten van melk beïnvloedt. Het lijkt erop dat vastenpraktijken de consumptie van melk op twee manieren beïnvloeden. Enerzijds wordt consumptie rechtstreeks beïnvloed door vastenpraktijken aangezien Orthodoxe Christenen geen melk of andere dierlijke producten mogen consumeren tijdens vastenperiodes. Anderzijds hebben de vastenpraktijken een invloed op de beschikbaarheid en prijs van melk doordat er minder investeringen gebeuren in de melksector. De wijdverspreide vastenpraktijken in Ethiopië lijken dus bij te dragen tot een onderontwikkeling van de melksector in het land in vergelijking met andere landen in de regio (zoals Oeganda of Kenya) [13, 18]. Weinig onderzoekers hebben zich echter toegelegd op het bestuderen van deze materie.

Om te onderzoeken hoe het melksysteem in Ethiopië zich heeft ontwikkeld binnen deze religieuze context, focussen we op drie verschillende onderzoeksvragen. Elk van deze vragen bestudeert een andere element van het melksysteem. Zo onderzoeken we niet alleen hoe religie een invloed heeft op melkconsumptie of op melkproductie, maar ook op melktransacties. We geven antwoorden op deze vragen in vijf verschillende hoofdstukken.

In een eerste hoofdstuk (Hoofdstuk 3) bestuderen we de impact van een lange vastenperiode op de melkinname in Ethiopië. We zien dat niet alleen de groep van Orthodoxe Christenen een impact ondervinden van Orthodoxe vastenrituelen. Tijdens Orthodox vastenperiodes consumeren niet alleen Orthodoxe Christenen minder melk, we observeren dat ook andere religieuze groepen minder melk consumeren, doordat er minder melk beschikbaar is, vooral in Orthodox-dominante plaatsen.

In een tweede en derde hoofdstuk (Hoofdstuk 4 en 5) onderzoeken we hoe melk-producerende huishoudens zich aanpassen aan de vraagschommelingen die veroorzaakt worden de vele vastenperiodes. We focussen daarbij op twee verschillende melkproductiegebieden met een Orthodoxe meerderheid: het gebied rond de hoofdstad Addis Ababa en de stad Mekelle. We ontdekken dat melk-producerende huishoudens twee keer beïnvloed worden door vastenpraktijken. Enerzijds, aangezien deze huishoudens grotendeels of bijna uitsluitend Orthodox Christen zijn, beperken ze hun eigen inname van melk tijdens vastenperiodes, wat natuurlijk melkoverschotten creëert. Anderzijds zijn er minder mogelijkheden om de melk te vermarkten tijdens vastenperiodes doordat de vraag naar melk afneemt. Producerende huishoudens gaan op verschillende manier om met deze melkoverschotten: (1) sommige verminderen de totale productie van melk op hun boerderij

door hun koeien droog te zetten op het moment van vastenperiodes en/of ze minder kwaliteitsvolle voeders te geven; (2) andere geven meer melk aan hun jongste kinderen; (3) bijna alle huishoudens verwerken meer melk tot langer houdbare producten zoals kaas en boter; en (4) huishouden met een goede toegang tot de markt – meestal degenen die dichtbij of in grote steden opereren – kunnen melk blijven verkopen tijdens vastenperiodes zonder dat ze hun verkochte volumes te veel moeten wijzigen. We merken ook dat de wijdverspreide traditionele verwerking van melk door deze producerende huishoudens vooral bedoeld is om hun consumptie te stabiliseren en niet zozeer hun verkoop aangezien de verkoop van verwerkte melkproducten amper stijgt buiten vastenperiodes.

Nadat we aangetoond hebben hoe religieuze vastenrituelen de consumptie en productie van melk beïnvloeden, vragen we ons af of religie – dat een deel is van iemands (sociale) identiteit – een beïnvloed heeft op de keuze met wie mensen bij voorkeur melk verhandelen. We bestuderen daarom hoe het delen van dezelfde religie melktransacties vergemakkelijkt zowel voor consumenten die melk aankopen (Hoofdstuk 6) als voor producten die melk verkopen (Hoofdstuk 7). Er is reeds aangetoond dat etnische marktsegmentatie voorkomt in Afrika [19, 20], maar religieuze marktsegmentatie werd totnogtoe onvoldoende bestudeerd. We tonen aan dat een grote groep van consumenten die we interviewden, rekening houdt met de religieuze overtuiging van melkverkopers wanneer ze beslissen van wie ze melk kopen. Deze consumenten verkiezen verkopers met dezelfde geloofsovertuiging en zijn bereid om meer te betalen of verder te wandelen wanneer de melk verkocht wordt door een verkoper met dezelfde geloofsovertuiging. Producenten discrimineren gemiddeld genomen niet wanneer ze moeten kiezen tussen verschillende potentiële kopers, maar we observeren een significante heterogeniteit van deze groep in hun voorkeur voor de geloofsovertuiging van kopers. Dit betekent dat sommige producenten geen of geen sterke voorkeur hebben voor de geloofsovertuiging van potentiële kopers, daar waar andere producers net wel een sterke voorkeur vertonen. Verder onderzoek is nodig om de aanwezigheid van religieuze voorkeuren te bestuderen zowel langs de kant van de kopers als langs de kant van de verkopers, maar onze resultaten lijken erop te wijzen dat religieuze segmentatie aanwezig kan zijn in de Ethiopische melkmarkt.

Dit doctoraat besluit dat Orthodoxe vastenpraktijken een onmiskenbare invloed hebben op de consumptie en productie van melk in Ethiopië, waardoor aanzienlijke marktinefficiënties ontstaan, aangezien de markten grotendeels verdwijnen en dan vooral in dominant-Orthodoxe settingen. Bovendien vinden we bewijs dat coördinatieproblemen bestaan tussen religieuze groepen. Om het potentieel van de Ethiopische melksector te verbeteren, zijn interventies nodig die het effect van seizoensgebonden vraagschommelingen verzachten en mogelijks het rendement op investeringen in de sector verhogen. Om dit te bereiken, zijn verdere inspanningen nodig om boeren te ondersteunen, verwerkingspraktijken te verbeteren, de beschikbaarheid van koelcentra voor opslag te vergroten, de markttoegang te verbeteren en ook transportfaciliteiten te verbeteren om markten

te integreren zodanig dat melk en melkproducten kunnen vermarkt worden naar gebieden waar vastenpraktijken een kleinere invloed hebben. Bovendien zou investeren in melkprogramma's op scholen een effectieve manier kunnen zijn om de melkconsumptie van kinderen te verhogen, aangezien dergelijke programma's het tegelijkertijd mogelijk maken een permanente afzetmarkt voor melk te creëren, aangezien kinderen niet moeten deelnemen aan vastenpraktijken. Tenslotte is het nodig om nutritionele kennis te vergroten door middel van sensibiliseringscampagnes. Dit om de consumptie van melk in Ethiopië te doen toenemen, maar ook om de sociale normen te kunnen beïnvloeden die kwetsbare bevolkingsgroepen dwingen om deel te nemen aan de vastenperiodes, aangezien het is aangetoond dat dit negatieve gevolgen heeft voor de gezondheid van dergelijke groepen.

CHAPTER 1

Introduction

1. General introduction and research scope

Food demand is increasing worldwide due to a growing population. Simultaneously, increasing per capita income levels boost per capita food consumption, a trend that is especially visible in developing nations. Food baskets in these nations are rapidly diversifying and increasingly include animal-sourced foods (ASFs) such as milk, meat, and eggs. Yet, the contribution of ASFs to total protein intake remains limited, only 20%, in low-income countries [2]. Increased consumption of ASFs, however, has the potential to significantly improve nutritional outcomes in many developing countries, particularly among young children, pregnant and breastfeeding women, because of the high-quality nutrient content in ASFs [21, 22]. The low inclusion of ASFs in children's diets is believed to be a main driver – among other factors – of the high prevalence of malnutrition in sub-Saharan Africa (SSA) [23]. Studies have shown that consumption of ASFs by undernourished children improves anthropometric indices and cognitive function and reduces the prevalence of biochemical and functional nutritional deficiencies, therefore reducing morbidity and mortality [24]. Especially milk has shown to be beneficial for physical growth and for brain and bone development [25-27]. Therefore, food-based dietary guidelines for healthy diets prescribe an average daily consumption of 250 mL of liquid milk for adults and 500 mL and 600 mL for children and adolescents respectively [10].

Annual growth rates of per capita milk, meat, and egg consumption in SSA have been stagnant to slightly negative over the past decades [3], and per capita calorie availability of ASFs is projected to decrease with nearly 5% in the coming decade [2]. This trend has very often been attributed to a supply chain that could not keep pace with an increasing demand for ASFs. This has influenced local policy programmes that are increasingly advocating a transformation of the livestock sector. Primary focus of these livestock interventions is often productivity-based, which is seen as a major bottleneck of the SSA livestock system. Less understood is how religion influences the livestock sector development, making it difficult to design effective policies to mitigate the potential effects of religion on ASF consumption and production.

In this dissertation, we investigate how religion shapes ASF demand and supply patterns. We specifically target religion – being part of a larger socio-cultural context – because of the explicit association between religious beliefs and practices on the one hand, and ASFs on the other hand. For ages, people have practiced their religion through food and various religious groups lay out food instructions to their adherents. These instructions often apply to ASFs and can be temporal (e.g. fasting rituals that require abstinence from ASFs and/or other foods) or permanent (prohibition to consume pork in Jewish and Islamic faith). Studies have shown that despite food being available and accessible, individuals might still not consume specific food items because of their religious traditions [28].

Religion – and culture at large – thus influences consumption habits and might explain why consumption of ASFs per capita does not increase significantly with increased availability and/or income growth. As religion affects food choices and food consumption behaviour, religion is expected to alter the food system at large [4]. Still, the role of religion in affecting food choices, demand, and supply is underemphasized in economic literature [5], while it is thought that the impact of religion on food systems will remain important given the growing share of religious people worldwide, and especially in SSA. Overall levels of religious commitment in SSA are among the highest in the world both among the younger and older generations. Nearly 90% of the population in the region indicates that religion is very important in their daily lives and 80% goes to worship services weekly [29].

But, religion manifests itself as a true devil in the detail. Not only is its impact not well understood, its impact is often not directly noticeable (it is ‘hidden’). In the case of food, the impact of religious dietary rules on food demand and supply is obvious. Less obvious is the role of religion in shaping attitudes and preferences, through norms and values [30]. Moreover, religion is also part of one’s social identity – next to other factors such as nationality, ethnicity, and gender – and thus impacts intergroup behaviour. Not properly accounting for the impact of religion is problematic both from a policy and scholarly perspective, leading to less or even ineffective interventions and blind spots in academic literature. But, singling out the impact of religion is a laborious task that takes time and effort. To simplify this, economic studies have often operationalized religion in terms of religious affiliation, i.e. what you believe, thereby dividing individuals over different religious groups (Catholic, Protestant, Orthodox Christian, Jew, Muslim, etc.) or by focusing on specific religious rules such as fasting practices. As religion cannot be seen as an isolated phenomenon but rather as a part of a larger socio-cultural context, research focusing on religion should be case-based and research findings from particular localities cannot be readily extrapolated to others.

This dissertation aims at exploring how the milk system in Ethiopia has evolved and adapted to the diverse and long-standing religious context in the country. Yearly milk intake in the country reaches only 20.6 kg per adult equivalent [8], which is only half of the sub-Saharan African average [9]. The food-based dietary guidelines for healthy diets prescribe an average daily consumption of 250 mL of liquid milk for adults and 500 mL and 600 mL for children and adolescents respectively which equals a yearly consumption of minimum 90 L per capita [10]. Ethiopia’s per capita milk intake thus falls short of the prescribed intake by more than four-fifth. Moreover, in contrast to the rapid growth in crop output and productivity recorded in Ethiopia, ASF output has grown slowly and productivity has stagnated. This has seemingly been due to low availability and adoption of improved inputs in the sector leading to high and increasing prices for ASF products [31]. High prices and low incomes make ASFs luxury goods and thus curtail demand for ASFs in the country.

Yet, insufficient attention has been paid to widely occurring fasting practices by the large Orthodox community in the country that possibly contribute to the underdevelopment of the country's dairy sector compared to other countries in the region (e.g. Uganda and Kenya) [13, 18]. Fasting rituals embedded within the Orthodox community, the dominant religious group in the country, create significant demand swings for ASFs due to the seasonal fasting rituals. This demand seasonality seems to offset investments in the livestock sector to a large extent, as actors along the value chain can insufficiently cope with the cyclical pattern of ASF demand.

We operationalize religion's impact on the milk system in this dissertation in two ways: (1) we detail the impact of a religious practice, i.e. fasting, on milk consumption, production, and output use, and (2) we investigate if the religious affiliation of potential trading partners affects trading preferences of both milk producers and milk consumers.

We select Ethiopia as a case study because of its religious diversity and its large group of Orthodox Christians. The country is home to 36 million Orthodox Christians, hosting the largest group of Orthodox Christians outside Europe [32]. Orthodox Christians are the dominantly religious group in Ethiopia, but surprisingly, this religious group has been neglected within scholarly studies, while research has looked at religious minorities such as Mormons (16.3 million adherents worldwide [33]), Jews (14.6 million [34]), and the Amish (330,000 members [35]). Ethiopian Orthodox Christians abstain from ASFs during multiple fasting periods spread over a year. Both one-day fasts and longer fasting periods occur, with long fasting spells in February-March (55 days), July (10-40 days), August (16 days), and December-January (40 days). Long fasting periods usually proceed holy events (such as e.g. Christmas and Easter). Orthodox Christians fast for about half of the year (166-250 fasting days yearly on average) [8, 16, 17]. Fasting practices cause significant milk demand seasonality in the country, where periods of reduced milk demand (fasting) are followed by periods of high demand caused by religious festivities at the end of fasting periods. This milk demand seasonality highly influences milk production, processing, and marketing practices. We specifically tackle cow milk as it is the most important animal protein source in Ethiopian diets. While Ethiopia has a long tradition of cattle herding and is believed to have the largest stock of cattle head in SSA [36] with more than 12 million households owning cattle [37], milk is not regularly consumed in the country because it is a luxury product. When milk is consumed by households, it is mainly intended for children or other vulnerable population groups (such as elderly and pregnant or lactating women) [6, 7].

The dairy sector is interesting from a development perspective for various reasons, i.e. because of (1) its potential to improve food security and nutrition, (2) its ability to combat poverty, (3) its gender inclusiveness and (4) the various employment opportunities it generates throughout the value chain. ASFs are valuable and dense sources of several micro and macronutrients which are hard to retrieve in adequate amount from plant source foods only [38]. Of all ASFs, milk is the largest source of

animal-based protein in developing countries, and it accounts for 60% of the total per capita consumption of primary ASFs (i.e. meat, milk, and eggs) [3]. Compared to other plant and animal protein sources, milk has one of the lowest production costs [39]. Stimulating the development of a supply chain that provides milk at low costs is thus a desirable strategy to improve nutritional and health outcomes, especially in SSA where half of the world's malnourished population is residing, and where diets predominantly consist of cereal or root staple crops [40]. Dairy development is not only a powerful tool for improving food security and nutrition, it is also a valuable strategy to reduce poverty. More than half of the extremely poor worldwide – who live with less than one USD per day – depend predominantly on livestock, and notably small-scale dairying, so as to produce food, to generate cash income, but also to manage risks and to build up assets [41]. Moreover, many of these smallholders are women – in East Africa, women account for more than 70% of the smallholder dairy farmers [42]. Finally, small-scale milk production also creates numerous employment opportunities throughout the dairy chain for small-scale processors, intermediaries (transporters, traders, collectors), and retailers [43].

Before presenting our main research objective and research questions in more detail, we first conceptualize religion within economic literature. We specifically highlight the intertwined relation between religion and food and how economic research has looked at the role of religion in consumer behaviour and in the food supply chain.

2. Theoretical literature review

2.1. Conceptualizing religion within economic literature

“The word ‘religion’ comes from the Latin root religio which signifies a bond between humanity and some greater-than-human power. Scholars identify at least three historical designations of the term: a supernatural power to which individuals are motivated or committed; a feeling present in the individual who conceives such a power; and the ritual acts carried out in respect of that power [44].”

From Hill et al. [45]

Religion has been defined as a “shared set of beliefs, activities and institutions premised upon faith in supernatural forces” [46]. Religion is a complex phenomenon and multidimensional in nature. It has been extensively studied in a variety of disciplines, notably philosophy, theology, history, anthropology, and sociology. Religion only recently regained interest from economists [47]¹. For a long time, mainstream economics depicted humans as rational agents with stable preferences that maximize utility in any given situation and pursue their own self-interest. But, starting from the early 1990s, this *homo economicus* model came to be questioned [49]. Economists increasingly acknowledge that individual preferences, decisions and actions, but also institutional structures are influenced by a larger socio-cultural context, of which religion is a part, and therefore should not be omitted from economic analyses [30].

Yet, economic literature on religion is still thin because research on the topic is challenging due to the limited availability of reliable data, the difficulty to operationalise religion, and the challenge to establish causal relationships. Because religion is part of a larger socio-cultural context and thus not an isolated phenomenon, one cannot readily isolate the impact of religion nor pinpoint the exact channels through which religion operates². Most research thus has established correlational patterns between religion and outcome variables, among others, marriage patterns [50], educational attainment [51, 52], migration intention [53], sanitation practices [54], fertility rates [55], female labour force participation [56], aid allocation [57], service supply [58], resource management [59], corruption [60], happiness [61], economic growth [48, 62], and agricultural productivity [63, 64].

Taking stock of the current state of knowledge is difficult because economic literature on religion is highly fragmented. Religion has been studied within various economic branches (among others identity economics, labour economics, public economics, behavioural economics, health economics, institutional economics, development economics, consumer behaviour, marketing research and

¹ As early as 1776, Adam Smith explains why religion might have economic advantages and thus influence economic transactions. In his book ‘Wealth of nations’, Smith claims that an individual’s reputation and trustworthiness might be deduced from his or her membership in a religious group, which thus reduces uncertainty and risks in transactions. Furthermore, he argues that religious groups provide extra-legal means to establish trust and to sanction free-riders [48].

² We acknowledge that economic studies also have treated religion as a dependent variable examining, among other things, the individual incentives for religious beliefs.

economics of religion). Compiling an overarching literature review of these religious studies is outside the scope of this dissertation. In what follows, we elaborate on the link between religion and food.

2.2. Religion and food

What we eat, how and why we produce, process, store, distribute, obtain, prepare, share, present, and eat food, mirrors long-lasting religious traditions [65-67]. Religion affects food consumption, production, and marketing practices in various and complex ways. We will highlight a few potential pathways through which religion can operate. First, religion informs norms and values that are highly persistent over time and which in turn shape attitudes and preferences [30]. A prominent example in this regard is the influence of religion in shaping gender roles, family structures, and decision power dynamics which influence a household's food production, purchase and especially food allocation among household members [67]. Second, religion can also be seen as a determinant of one's social identity. Identity-based inclusion or exclusion still occurs widely and affects participation in and access to opportunities, resources, and activities [68]. What might be relevant here is not only the exclusion from agricultural inputs that affects production, and the exclusion from jobs that might impact economic access to food, but also the exclusion from food assistance programmes. Third, certain religious groups have specified procedures on livestock slaughtering and food preparation (Judaism and Islam). Finally, many religious groups lay out formulated rules on dietary intake with prescriptions on what food can be consumed and proscriptions on what cannot be consumed, and when one should abstain from consumption of all or particular foods.

Scholarly studies have predominantly focused on religious dietary rules. Dietary rules not only affect food choices, but also affect what food is produced and marketed. Some of these rules are absolute while others only tackle certain population groups [69]. Religious prescriptions and proscriptions can be permanent or temporal. Permanent food prescriptions can be found within the Jewish and Islamic traditions, who impose their members to limit consumption to kosher and halal foods. A permanent food proscription is the avoidance of pork in Islam and Judaism, beef in Hinduism and meat at large in Buddhism. Fasting rituals are an example of temporal food restrictions, such as Ramadan observed by Muslims, which requires total abstinence of any food and drink from dawn till sunset or fasting among Orthodox Christians, during which believers abstain from consuming ASFs.

The type, importance, and impact of these dietary rules are highly context-dependent [67]. First, while some religious groups share similar food proscriptions and prescriptions, dietary rules still vary significantly. The type of religious dietary rules practiced will thus depend on which religious groups are present in specific localities. Second, religious groups are non-randomly distributed which results in a variety of religious settings where religious groups, with their own set of dietary rules, are not equally represented. The importance and impact of religious dietary rules will thus depend on the density of religious practitioners being present. Third, compliance to dietary rules varies which also affects the importance and impact of religious dietary rules. Strong social norms can lead to strict enforcement and make food barely accessible, despite it being available and affordable [69].

Moreover, dietary laws can also become highly internalized. Individuals may not consume certain foods (e.g. pork) and highlight that feelings of disgust mainly drive this aversion, rather than explicit religious rules [70]. If enforcement is flexible, the impact on food choice will depend on the costs and benefits an individual derives from observing religious rules [67].

Different explanations have been put forward as to why religious groups regulate food intake. Iannaccone [71] postulates that prohibitions are a solution to free-rider problems. By prescribing distinct rules, less committed members (i.e. potential free-riders) are discouraged to remain part of the religious group. Moreover, he posits that the more prohibitive the imposed rules are, the greater the participation of the respective group members and the greater the provision of public goods to the group as a whole, which ultimately impacts group cohesion. Coşgel and Minkler [72] argue that prescriptions and proscriptions assist in the communication of a religious identity and help to differentiate from out-group members and to foster in-group cohesions. Moreover, it serves as a device to show the degree of commitment to a certain religious belief and helps to mark social status. Other commonly cited reasons for religious food prescriptions are related to food safety³, animal welfare (mostly domesticated animals), health, and ecological concerns [69, 73-75].

Economic research has largely neglected the link between religion and food. In what follows, we will highlight the available literature that has linked religion and consumer behaviour as well as religion and the food supply chain. To the best of our knowledge, we are the first to compile such an overview on the topic, and we could only find one study that detailed a part of it, i.e. the paper by Briones Alonso et al. [67] that reviews the impact of culture on food availability, access, utilization, and stability.

³ A well-known example is the religious restriction on the consumption of pork, as pigs are known to bear a lot of sickness-causing parasites [69].

2.2.1. Religion and consumer behaviour

Consumer choices are complex and steered by a multitude of factors: product or service characteristics, individual determinants but also external factors such as sociological, ecological, environmental and cultural factors [76]. The influence of religion has, until recently, often been overlooked in consumer and marketing research. More evidence is now published, but studies on the effect of religion on consumption patterns remain scarce and scattered [77].

Table 1-1 and Table 1-2 provide a snapshot of the literature that has been published on the link between religion and consumer behaviour. By no means these overviews are a complete record of all papers published on the topic. The papers show that all major religions influence consumer behaviour. Research has predominantly assessed the impact of religion on an individual level focusing on either single (Table 1-1) or multiple religious groups (Table 1-2) within different religious settings (dominant, minority or diasporic). Studies focusing on a single religious group have operationalized religion as a religious practice, while studies focusing on multiple religious groups, instrumentalize religion as a combination of religious affiliation (i.e. what you believe) and religiosity (i.e. how strong you believe), with some papers focusing solely on the impact of religious affiliation or religiosity, while others include both.

Research studying a single religion has largely looked at the Islam, evaluating purchase and consumption intentions of halal products (particularly meat) as well as food intake during Ramadan. Studies on other religious groups predominantly investigate the link between religious food beliefs, laws, and diets. Majority of the papers have been carried out in Western developed countries (e.g. Canada, United States, Greece, Belgium) and some in South Asia and the Middle East. The existing literature on Orthodox Christianity focuses predominantly on Greek Orthodoxy and looks at how Orthodox fasting rituals affect food intake [78-80].

Studies across multiple religious groups have directed shopping behaviour and other key aspects of consumer behaviour more, such as product preferences, consumer innovativeness, information seeking, and ethical concerns. This research strand compares consumer attitudes, preferences and behaviour across different religious groups and/or different intensities of beliefs. Such research is interesting for marketing purposes as it allows to characterize different consumer segments [81]. Evaluation of substance use (e.g. tobacco and alcohol) across religious groups and levels of religiosity is also common. Many of the listed studies have been carried out in the United States.

A second, different, stream of literature – which we do not attempt to elaborate extensively in this dissertation – discusses how religion, through its impact on dietary intake, influences health and performance outcomes. Papers in this area connect religious dietary rules and practices to body weight, metabolism, diseases, mental health, and cognitive and physical performances, to name but

a few (Table 1-3). In this literature stream, primarily fasting practices are studied, with a lot of publications on the effect of Ramadan fasting.

Table 1-1: Scholarly studies that have published on the link between religion and consumer behaviour within a single religious group

Religious affiliation	Research topic	Research country	Data	Respondents	Author(s)
Islam	Determinants of halal meat consumption within a Muslim migration population	France	Scale type questions	576 Muslims currently living in France, aged above 18 and involved with meat purchasing decisions within the household	Bonne et al. [82]
Islam	Preferences for shopping halal meat in supermarkets versus local shops	United Kingdom	Multiple choice questions and scale type questions	300 Muslims	Ahmed [83]
Islam	Level of dietary practices (Ramadan and halal)	Belgium	Scale type questions	981 second-generation Turkish and Moroccan respondents aged between 18 and 35 years old	Güngör et al. [84]
Islam	Willingness to buy and pay for certified halal labelled meat at the supermarket and the Islamic butcher	Belgium	Consumption frequency scale and scale type questions	202 Muslim consumers aged above 18	Verbeke et al. [85]
Islam	Determination of major dietary patterns among fasting subjects	Iran	Food frequency questionnaire	587 fasting subjects	Shadman et al. [86]
Islam	Effect of Ramadan on beer consumption	Turkey	Quantitative data on, among others, beer sales and number of Ramadan days for each month	50 monthly observations on 11 brewery products	Çelen [87]
Judaism	Influence of Jewish religion and Jewish dietary laws on family food habits	Canada	a. Food frequency questionnaire and food habits list b. 2-day food record	a. 250 ultra-orthodox households b. 250 adults (subsample from a.)	Shatenstein et al. [88]
Judaism	Link between religiosity and influence of each family member on the type of food purchased	Israel	Number of meals each week that contain a certain meat product and	312 adults responsible for shopping	Just et al. [89]

				preferences of family members for several types of meat		
Judaism	Link between religiosity and health behaviour, use of medical check-ups, and eating habits	Israel	Food frequency questionnaire	3,056 adult (18+) urban citizens	Shmueli and Tamir [90]	
Buddhism	Link between religiosity and health practices (including dietary behaviour)	US	Yes/no questions regarding the adherence of a vegetarian diet and the exclusion of specific animal food sources	886 respondents aged 18 or older	Wiist et al. [91]	
Seventh-Day Adventists	Characterize and compare food consumption patterns of several vegetarian and non-vegetarian diets	US and Canada	Food frequency questionnaire	89,455 subjects from Adventist Health Study 2 cohort	Orlich and Fraser [92]	
Seventh-Day Adventists	Link between religiosity and diet	Malaysia	Food frequency questionnaire	574 respondents aged above 18 years old	Tan et al. [93]	
Eastern Orthodox Christianity	Beliefs and practices with regard to fasting	US	Field notes, open ended questionnaire regarding beliefs and stated practices during fasting and secondary data	58 respondents aged 18 or above that attends a local parish	Quinton and Ciccazzo [94]	
Greek Orthodox Christianity	Description and evaluation of three traditional diets of Crete	Greece	7-day weighted food record	1 food sample from each traditional diet	Kafatos et al. [95]	
Greek Orthodox Christianity	Impact of fasting on dietary habits	Greece	24 hours dietary recall and 3-day weighted food record	120 respondents aged between 20 and 60 years old, having no chronic diseases and taking no medication	Sarri et al. [79]	

							or dietary supplements; 60 of the 120 were fasters, while the other 60 were non-fasters		
Greek Orthodox Christianity	Assessment of calcium, nutrient and food intake during fasting and normal (non-fasting) week	Greece	7-day record	weighted	food	10 monks aged between 20 and 60 years old in good health, non-smokers, taking no medication that influences Ca bioavailability	Papadaki et al. [80]		
Ethiopian Orthodox Christianity	Frequency of fasting, extent of obedience to fasting rules, and food consumption during fasting and non-fasting periods	Ethiopia	a. 7-day weighted record b. Food intake (24 hours recall)			a. 9 households having at least 1 child below 3 years or age from the sample of the Ethio-Swedish Children's Nutrition Unit in Addis Ababa and Ijaji b. 20 factory workers in Addis Ababa	Knutsson and Selinus [78]		

Table 1-2: Scholarly studies that have published on the link between religion and consumer behaviour across multiple religious groups

Research topic	Research country	Data	Respondents	Author(s)
Effect of religious affiliation (Catholicism, Judaism and Protestantism) on shopping behaviour (furniture case)	US	Recorded presence as well as whether anything was purchased in the shop	854 households visiting specific furniture shop	Thompson and Raine [96]
Effect of Jewish ethnicity on selected aspects of consumer behaviour (e.g. information seeking, product information transfer)	US	Open questions, frequency scales and scale type questions	a. 298 university students majoring in Business Administration b. 363 adult consumers residing in NY metropolitan area	Hirschman [97]
Link between religion (Catholicism and Judaism) and religiosity and the role of husbands and wives in households' consumer decision making processes (automobile case)	US	Perceived influence on eight dimensions of purchase by each spouse (Likert-type scale)	207 households that purchased a new automobile in the past year prior to the interview	Delener [98]
Influence of nationality and religiosity on aspects of shopping behaviour (radio set case)	Japan and US	Scale type questions	230 respondents between 18 and 45 years old (125 Japanese and 105 Americans)	Sood and Nasu [99]
Influence of religiosity (Catholicism, Fundamentalism, Protestantism and others) on propensity to outshop and to Sunday shop	US	Scale type questions	338 respondents who do most of the shopping for the household from area	Siguaw and Simpson [100]
Impact of religiosity on cigarette smoking	US	Quantitative cigarette use	3968 respondents aged 65 or older	Koenig et al. [101]
Influence of Irish Catholic descent on dietary pattern	Scotland	Food questionnaire frequency	985 Irish descendants of the 35-age cohort in the 'west of Scotland Twenty-07 study'	Mullen et al. [102]

Influence of religious affiliation (Hinduism, Islam, and Catholicism) on shopping behaviour (television set case)	Mauritius	Scale type questions	1,000 household heads	Essoo and Dibb [103]
Impact of religious affiliation and religiosity on newspaper readership frequency and uses (Mormonism, Orthodox Judaism, and Methodism)	US	Scale type questions	70 respondents from each of the 3 different affiliations	German [104]
Impact of religious affiliation (Judaism, Islam, and Christianity) and religiosity on consumer preference of various chicken products and meat types	Israel	Open questions and scale type questions	388 households	Heiman et al. [105]
Impact of religious affiliation and religiosity on alcohol drinking	US	Alcohol frequency use	7,370 adults (18 or older)	Michalak et al. [106]
Impact of religiosity on ethical attitudes	US	Scale type questions	127 adult consumers	Vitell et al. [107]
Comparing body composition and nutrient intake among Buddhist vegetarian and omnivore Catholic nuns	South Korea	3-day dietary record	54 Buddhist nuns and 31 Catholic nuns who are healthy, did not take any medication, and no dietary supplements for the past 6 months	Lee and Krawinkel [108]
Link between religious affiliation (Buddhism, Catholicism, Protestantism, and non-affiliation) and religiosity and product- and store-switching behaviour	South Korea	Scale type questions	496 working individuals above 18 years old	Choi [109]
Consumption rituals during central holy days (Christmas, Ramadan, and Passover) across three different cultural settings of the religious community (dominant, minority, and diasporic)	Israel, Tunisia, and US	Qualitative interviews	in-depth 43 respondents	Hirschman et al. [110]
Difference between the impact of religiosity on ethical consumer behaviour among two religious affiliations (Christianity and Islam)	Germany and Turkey	Scale type questions	471 university students in the field of Business Administration (231 Turkish Muslims and 240 German Christians)	Schneider et al. [111]

Impact of religiosity on brand reliance	US	Choice experiment where participants need to choose between two different products: one with national brand and another one with store brand	45 participants from public university	Shachar et al. [112]
Impact of religiosity on alcohol and tobacco use	Brazil	Quantitative alcohol and tobacco use	383 respondents aged 18 or older	Lucchetti et al. [113]
Impact of religiosity on alcohol use	US	Quantitative alcohol use, attitude and perception of policies and norms	2,312 undergraduate college students	Burke et al. [114]
Impact of religiosity on alcohol and tobacco use	Brazil	Alcohol and tobacco frequency use	363 respondents aged 18	Queiroz et al. [115]

Table 1-3: Scholarly studies measuring health and performance outcomes of religious practices within religious groups

Religious affiliation	Religious practice	Measured outcome(s)	Author(s)
Islam	Fasting	Body weight and composition, metabolism, blood concentration levels, breast milk composition, and diseases and disorders	Temizhan et al. [116], Bogdan et al. [117], Leiper et al. [118], Salti et al. [119], Benaji et al. [120], Dewanti et al. [121], Rakicioğlu et al. [122], Ziaee et al. [123], Bouhlef et al. [124], Haouari et al. [125], Ibrahim et al. [126], Maughan et al. [127], Khaled and Belbraouet [128], Lamri-Senhadj et al. [129], Al-Arouj et al. [130], Hui and Devendra [131], Farooq et al. [132]
		Performance (e.g. educational, cognitive, physical, behavioural)	Kadri et al. [133], Karaagaoglu and Yucecan [134], Roky et al. [135], Chaouachi et al. [136], Aziz et al. [137], Aziz et al. [138], Chtourou et al. [139], Aloui et al. [140], Oosterbeek and van der Klaauw [141], Shephard [142], Bouhlef et al. [143], Fenneni et al. [144], Muhamed et al. [145], Rebai et al. [146], Almond et al. [147], Baklouti et al. [148], Havenetidis [149], Talib et al. [150], Chamari et al. [151], Cherif et al. [152], Laatar et al. [153], Ovayolu et al. [154], Zarrouk et al. [155]
Judaism	Fasting	Metabolism, blood concentration levels, delivery, breast milk composition, and diseases and disorders	Drescher and Elstein [156], Marcus et al. [157], Zimmerman et al. [158], Lurie et al. [159], Grajower and Zangen [160], Becker et al. [161], Metzger et al. [162], Shalit et al. [163]
Buddhism	Fasting and vegetarianism	Body weight and composition, metabolism, blood concentration levels, mental health, and diseases	Ho-Pham et al. [164], Wayment et al. [165], Jung et al. [166], Kuramasuwan et al. [167], Zhang et al. [168], Stewart et al. [169], Choi et al. [170], Tanaka et al. [171]
Seventh-Day Adventists	Vegetarianism Veganism	Body weight and composition, metabolism, blood concentration levels, diseases, disorders, and mortality	Vang et al. [172], Chan et al. [173], Rizzo et al. [174], Pettersen et al. [175], Thygesen et al. [176], Orlich et al. [177], Thygesen et al. [178], Kwok et al. [179], Le and Sabate [180], Orlich and Fraser [92], Fraser et al. [181], Schneekloth et al. [182]
Mormons	Prohibited consumption of tobacco, alcohol, coffee and tea	Mortality, mental health, obesity, fertility, and diseases	Enstrom and Breslow [183], Mason et al. [184], Stanford and Smith [185], Sanders et al. [186]
Greek Orthodox Christianity	Fasting	Blood concentration levels, obesity, mental health, and anthropometric measures	Sarri et al. [187], Sarri et al. [188], Sarri et al. [189], Sarri et al. [190]
Christianity	Fasting	Blood concentration levels, mental and physical health, body composition, anthropometric markers, and metabolism	Bloomer et al. [191], Bloomer et al. [192], Alleman et al. [193]

2.2.2. Religion and the food supply chain

The food supply chain involves all the actors and activities that bring food from farm to fork: production, storage, distribution, processing, packaging, and marketing [194]. While many studies acknowledge the influence of religion on the food supply chain, barely any study includes religion's role as its main focus. From the studies we found that include religion as a main focus, the majority elaborates on the impact of religious dietary rules on the food supply chain, mainly focussing on religious labelling. We retrieved two studies in SSA that looked at the impact of religious work taboos on food production. Finally, while we found two studies in Malawi and Niger-Nigeria that detailed the effect of ethnic ties on food trade, so far, no study has looked into religious market segmentation.

Available literature mainly addresses the influence of religious dietary rules on the food supply chain. Most studies examine how the food industry has or can adjust its practices so as to serve the Jewish and Muslim consumer segment. We found studies carried out in the United States [195], Europe [196-198], the United Kingdom [197], and Israel [5]. Part of these studies focus on the specific case of meat. All these studies focus particularly on religious labelling. Both halal and kosher are credence quality attributes that cannot be readily evaluated or ascertained by consumers. This has led to a proliferation of labels issued by various certification bodies and religious authorities. The study of Heiman et al. [5] also discusses how retail has adjusted to different religious consumer segments with specialized supermarket chains serving particular consumer groups (secular Jews and Muslims, religious Jews, or religious Muslims). These chains vary in, among other things, their product assortment, where they are located, and their opening hours (whether or not they are open on Saturday, the day of rest for Jews, known as Sabbath). This shows how local food markets adapt to preferences of the present religious groups and modify their business practices in line with these preferences.

In Ethiopia, while some reports mention important effects of fasting on the value chain, there is a lack of quantitative and in-depth studies that map value chain actors' responses to Orthodox fasting practices. The few studies that exist, list anecdotal evidence on the impact of Orthodox fasting practices on farmers, processors, and retailers. As such, ADP-LMDP [12] and Herego [199] report that focus group discussions with farmers selling to cooperatives and processors revealed that these farmers experience drops in prices for milk of 18-56%. Limited demand as well as lower prices for milk reduce market incentives of dairy producers and it has been estimated that milk sales reduce by 20-25% during long fasting seasons [42]. Land O'Lakes [200] indicates that interviews with milk processors revealed that these producers cut down their capacity during long fasting periods with reductions of 25% being reported. Processors reduce their processing capacity during fasting by limiting the supply of milk during fasting using quota systems [12], paying lower prices, and/or requiring a higher milk quality [201]. Finally, Avery [202] reports that in the capital of Ethiopia, Addis

Ababa, 85% of the butcheries closes on traditional Wednesday and Friday Orthodox fasting days and 43% of the supermarkets reports a drop in meat sales on those days. Orthodox fasting thus does not only directly affect consumption of milk and other ASFs, but also availability and pricing of these foods. The upshot of previous studies is that they demonstrate how Orthodox fasting practices might affect the value chains of ASFs in Ethiopia. However, there is limited quantitative analysis on the effects of fasting and especially on how milk producing households deal with declining milk demand during fasting. A research gap we address in this dissertation.

Besides the impact of religious dietary rules, two studies in SSA have looked at the effect of religious work taboos on agricultural production in Madagascar [63] and Ethiopia respectively [64]. Stifel et al. [63] found that each additional day of religious work prohibition resulted in a 5% decrease of rice yield. In Ethiopia, Kijima and Gonzalez [64] find some evidence that during prolonged religious holidays with work prohibition, households shift from crop production to livestock production which is considered to be less labour intense.

Other studies have looked at the impact of cultural similarity (sharing cultural ties, such as common language, religion, or ethnicity) on bilateral trade volumes [203, 204]. Economic agents might decide to trade with trading partners that are part of the same cultural group or network because of preference motives and/or cost-reduction motives [205].

Preference motives arise because of the presence of intergroup bias, which in turn is the outcome of in-group favoritism, out-group hostility or both [206]. Whereas in-group favouritism represents preferential evaluation and treatment of the in-group relative to the out-group (to which the individual is indifferent), out-group hostility relates to (explicit) negative attitudes and behaviour towards out-group members. Intergroup bias can arise solely from in-group favouritism without any presence of negative feelings towards out-group members, and conversely it can also arise solely from out-group hostility [207]. Research has shown that intergroup bias occurs more often in the form of in-group favouritism rather than out-group hostility [208]. Intergroup bias ultimately affects intergroup behaviour and it has been extensively documented that people exhibit more in-group cooperation than out-group cooperation (for a recent review, check Balliet et al. [209]), although out-group cooperation does not necessarily fall to zero [210]. For trade, preference motives imply that economic agents value each other's products higher compared to products offered for trade by more culturally dissimilar trading partners. Such preferences, however, are absent for homogenous goods that are traded in anonymous transactions [204].

Cost-reduction motives can also explain why individuals resort to culturally similar trading partners. If trading partners that are more culturally similar trust each other more, this ultimately reduces transaction costs. As such, Guiso et al. [203] found that religious similarity in Europe positively

impacts trust: if 90% of the citizens in two countries share the same religion, trust increases by 15 percentage points compared to the case when the two countries do not share a common religion.

In SSA, we found two studies that evidence the existence of market segmentation along ethnic lines between farmers and traders in the maize value chain in Malawi [20], and the millet and cowpea value chain in Niger and the Niger-Nigeria border [19]. Robinson [20] found, using qualitative data, that this ethnic market segmentation arises most probably from limited interethnic trust. Since interpersonal trust is central to the functioning of markets and especially in SSA, where direct and arm-length trade is still common, it is also expected that religious market segmentation might occur, but this has not yet been studied.

2.3. Literature gaps

Economic literature on religion is highly fragmented and religion has been studied within various economic branches. We identify six major gaps. First, the impact of religion on food demand and supply is still underemphasized in economic literature [5]. Second, the available economic research on religion and food is biased towards high-income and Western developed countries. Third, research has predominantly focused on Islam. Fourth, scholarly studies have looked at either the link between religion and consumer behaviour or between religion and food supply, resulting in two separate literature streams. Fifth, most studies that looked at particular items, focused on meat or substances. And finally, available studies only detailed the impact of religious dietary rules within a particular group.

We aim to fill these academic voids and we contribute to literature in several ways. (1) We cast light on the role of religion in food system development; (2) we study this in Ethiopia, a low-income country, where the influence of religion might be particularly prevalent given its religiously active population that is highly observant; (3) we focus on a large, yet neglected, group of Orthodox Christians; (4) we take a comprehensive approach and focus on three elements of the milk system, that are intertwined and can therefore not be studied separately: consumption, production, and transactions; (5) we focus on a non-conventional product (milk); and finally (6) we detail the wider societal impact of the Orthodox fasting by focusing also on non-Orthodox households.

3. Main objective and research questions

In this dissertation, we take the case of Ethiopia and (cow) milk. Several reasons motivate this choice. Ethiopia hosts a large Orthodox community numbering to 36 million individuals, the second largest community of Orthodox Christians in the world. Research so far has neglected this religious group, while it has investigated smaller religious groups, notably Jews. The country has a strong connection with the Orthodox Church that established as early as the fourth century [64]. Besides Orthodox Christians, the country is home to 29 million Muslims, 16 million Protestants, 2 million people adhering to traditional faiths, and 600,000 Catholics [211]. We take the specific case of milk, because of the explicit association between the Orthodox religion and ASFs through the fasting practices. Additionally, milk is the main animal protein source in the country [8] and Ethiopia has a long standing tradition of cattle herding – its cattle herd is believed to be the largest in SSA [36] – and cow milk consumption.

Our central objective is to examine how the Ethiopian milk system has evolved within a diverse and long-standing religious context. To fulfil this objective, we adopt a comprehensive approach and we disentangle three main research areas within the milk system that require further investigation: milk consumption, production, and transactions. As we have shown above, food takes a special position in many religions, and various religious regulations specify which types of food can be consumed (by whom and when), and how food should be produced and handled. Yet, religion may also influence where people shop for food as well as to whom people sell their food.

The three research questions are summarized in the box on the following page. We answer these research questions in five chapters. For the first two research questions, we specifically look at the impact of Orthodox fasting rituals. In the third research question, we focus on religious affiliation, and investigate if sharing religious ties, by being member of the same religious group, affects milk transaction preferences of both milk producers and milk consumers. In what follows, we elaborate more on how we unpacked the different research questions in the respective chapters.

Main objective

Examining how the Ethiopian milk system has evolved within a diverse and long-standing religious context

Research question 1: How does religion influence milk consumption?

Chapter 3: Religion, food choices, and demand seasonality: Evidence from the Ethiopian milk market

Research question 2: How does religion affect milk production and output use?

Chapter 4: Fasting, food, and farming: Evidence from Ethiopian milk producers

Chapter 5: Milk in the city: Profiles and development paths for urban dairy holders in Ethiopia

Research question 3: Does religion interfere with milk transactions?

Chapter 6: Unravelling preferences for religious ties in milk transactions: A buyer perspective

Chapter 7: Is religion cueing trading behaviour of Ethiopian milk producers?

In Chapter 3, we examine how fasting rituals embedded within the Orthodox community affect household milk intake decisions. We focus on Orthodox Christian, Protestant, Muslim, and other religious households (i.e. Catholics and adherents of traditional faiths) so as to study whether fasting practices also affect milk consumption of non-Orthodox households. No study so far has detailed the quantitative impact of fasting on milk demand at a national level in the country. Literature review as well as interviews with key informants during our first field visit in January-February 2016, revealed that milk markets largely dissolve during Orthodox fasting periods, specifically in localities with large concentrations of Orthodox Christians. Therefore, we further investigate for households who indicate to consume milk, whether fasting, and especially increasing densities of Orthodox Christians, negatively affects their probability to source milk from the market.

Decreasing milk demand during Orthodox fasting obviously impacts milk producing households. In Chapter 4 and 5, we thus investigate how milk producing households have adjusted to these periods of reduced milk demand caused by fasting. We look at two different milk sheds: the Great Addis milk shed (Chapter 4) and the Mekelle milk shed (Chapter 5). While the Addis milk shed is the most market-oriented centre of the country, the Mekelle milk shed is much less developed but it is rapidly transforming. Both milk sheds host a majority of Orthodox Christians, 75% and over 95% respectively. Orthodox fasting will thus undeniably impact milk production systems in both areas.

Finally, we wonder whether the religious affiliation of potential trading partners plays a role in milk transactions. Particularly, we investigate if sharing religious ties, by being member of the same religious group, facilitates or inhibits milk exchange, both from a consumer (Chapter 6) and a producer (Chapter 7) perspective. Several reasons make us hypothesize that religion might be an

important factor in a consumer's/producer's (initial) selection of milk sellers/buyers: (1) the milk market that operates predominantly informally, (2) the religious symbolism of ASFs, (3) the widespread occurrence of co-religious networks due to low levels of trust in other religious groups and the geographical dispersion of religious groups, (4) and the occurrence of informational asymmetries that require trust from consumers/producers in milk sellers/buyers. This might result in coordination problems between different religious groups, which affects the willingness to trade among each other, resulting in market inefficiencies. Economic agents might decide to trade with trading partners that are part of the same religious group or network because of preference motives and/or cost-reduction motives [205]. Since milk is a homogeneous product, we expect that in the Ethiopian context, cost-reduction motives will be the most dominant underlying factor driving milk market transactions. Given the dominance of arm-length informal milk trade in the country, we hypothesize that trust is a crucial underlying condition of milk transactions. Trust can be established in various ways, of which one is shared membership in a social group. Milk transactions might therefore arise more easily among individuals that share the same religious affiliation.

Figure 1-1 visualizes the different building blocks upon which we focus in this dissertation. We look at three elements of a milk system: consumption, production, and transactions. This dissertation includes five chapters that each tackle a specific element. Chapter 3 will focus on the impact of Orthodox fasting on milk consumption decisions and from which sources this consumed milk is acquired (purchase or own production; both sourcing channels are visualized in Figure 1-1). Chapter 4 and 5 will investigate how milk producing households operate within a context of religious fasting, paying specific attention to the heterogeneity in adaptation strategies to Orthodox fasting periods. Finally, we will look at milk transactions, where Chapter 6 assesses consumer preferences for co-religious milk suppliers, while Chapter 7 evaluates milk producer preferences for co-religious milk buyers.

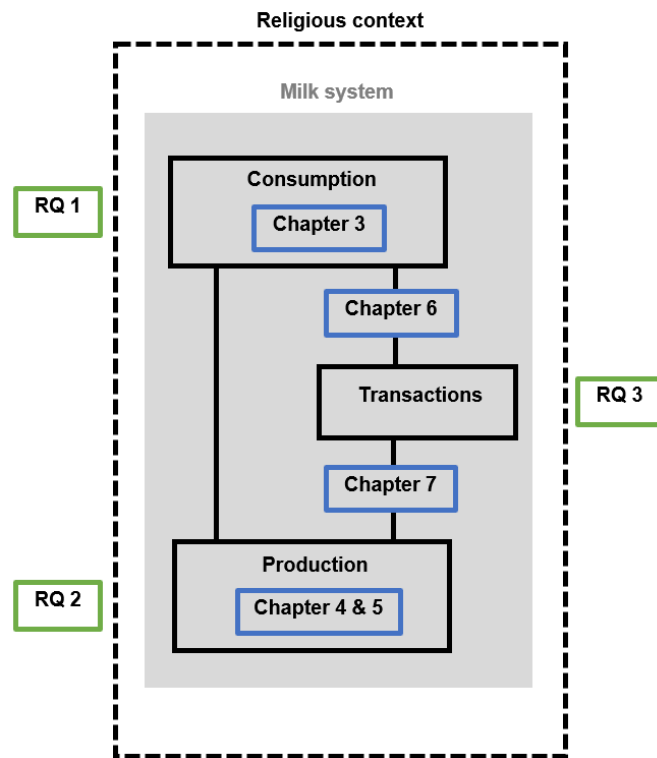


Figure 1-1: Dissertation overview

4. Data and methodology

During this dissertation, we collaborated with different researchers both within the department as well as outside of Ghent University (KU Leuven and the International Food Policy Research Institute (IFPRI)). These collaborations are highlighted at the beginning of each of the chapters. In this section, it is important to highlight the operational choices that were made in this dissertation so as to answer the three research questions.

As indicated above, we operationalize religion in two ways: as a religious fasting ritual and as religious affiliation. We look at the effect of the presence of an Orthodox fasting season on milk consumption (Chapter 3), and milk production and output use (Chapter 4 and 5) and we investigate if the religious affiliation of potential trading partners affects trading preferences of both milk consumers (Chapter 6) and milk producers (Chapter 7). Orthodox fasting spells consist of one-day fasts and longer fasting seasons, covering multiple days or weeks (which will be elaborated more on in Chapter 2). In this dissertation, we only focus on the impact of a long Orthodox fasting season.

This dissertation focuses both on milk consuming and milk producing households, residing in rural and urban areas. We use both secondary and primary data to fulfil our research objective. For our own fieldwork, we deliberately focused on urban producers and consumers, who remain a black spot within academic literature. Urbanization is proceeding rapidly in SSA and the total number of African dwellers is projected to rise from 400 million in 2010 to 1.3 billion by 2050 [212]. Urban farmers are still key to ensure a city's food security. Yet, urban agriculture is largely practiced informally, with farmers being mostly tolerated rather than supported by city governments. Urban food producers face many challenges, particularly regarding land access, tenure security and input provision. But, there is a growing awareness and appreciation for local urban food production, and therefore a need to gain a better understanding of the actors involved in the urban food sector [212].

This dissertation is innovative not only because of its subject (as elaborated in the previous sections) and study population (not only Orthodox Christians, but also non-Orthodox households and the particular focus on urban producers and consumers), but also because of the use of different datasets (secondary and primary data), study methods (i.e. observational studies with surveys (Chapter 3 to 5) versus controlled experiments (Chapter 6 and 7)), and modelling strategies. An overview is provided in Table 1-4.

We used two datasets from secondary sources: a first one that is part of the Living Standard Measurement Survey (LSMS) programme in Ethiopia, a household survey programme housed within the World Bank's Development Data Group, and the other one was collected within the project 'Improving the evidence and policies for better performing livestock systems in Ethiopia' lead by IFPRI as part of the Feed the Future Innovation Lab for Livestock Systems. These data sets were

used in the third and fourth chapter respectively. For the remaining chapters, I collected my own data in the city of Mekelle, northern Ethiopia. I conducted two separate fieldwork rounds, one in January-February 2016 and one in August-September 2017. In both phases, a team of enumerators, which I supervised, facilitated the data collection. These enumerators received a one-day training in which I familiarized them the research objective and research questions, and research design. More information on the practicalities of the interviews and collected data are discussed in the respective chapters.

To analyse the cross-sectional data, we employed various econometric models and techniques: linear probability models (Probits), linear regression models (Ordinary Least Squares regressions and Seemingly Unrelated Regression Equations), and choice modelling techniques (Discrete Choice Experiments). These methods are all predictive in nature and allow to estimate the impact of a variable of interest. We also employed a data mining strategy, cluster analysis, which is exploratory. The aim of such a technique is to sort and allocate observations in clusters and thus tries to identify similar behavioural patterns.

In what follows, we will highlight how we unpacked each research question into a specific research design.

Table 1-4: Overview of the data and modelling strategies employed in the different chapters

Chapter	Research question	Data source	Data type	Respondents	Sample size	Geographical focus	Area	Econometric methods
3	1	LSMS	Survey	HHs (both producing and consuming)	5,262	National	All – rural and (peri-)urban	Probit models
4	2	IFPRI	Survey	Producing HHs	870	Great Addis area	All – rural and (peri-)urban	Ordinary Least Squares regressions and Seemingly Unrelated Regressions Equations
5	2	Own data	Survey	Producing HHs	304	Mekelle city	Urban	Cluster analysis
6	3	Own data	Survey and discrete choice experiment	Consuming (purchasing) HHs	221	Mekelle city	Urban	Random parameter models
7	3	Own data	Survey and discrete choice experiment	Producing HHs	222	Mekelle city	Urban	Random parameter models

4.1. Research question 1

To answer our first research question, we used secondary data collected by the LSMS programme, a household survey programme housed within the World Bank's Development Data Group. We use data from the second collection round, which took place in 2013-2014. Data within this programme are nationally representative and include observations from 5,262 households spread over the country. This survey collects detailed data on household consumption of selected food items, including milk, using a seven-day recall period. It also details from which sources the consumed milk is acquired (production or purchase).

While the data collected in the LSMS programme were not intended to study the effect of long Orthodox fasting seasons on milk consumption, we could use this dataset because of the partial overlap of the timing of collection (February-April 2014) with the longest continuous fasting period of the Orthodox community, i.e. Lent, a 55-day fast preceding Easter. This timing allows us to compare milk intake decisions and milk acquisition strategies outside and during Orthodox fasting periods among the different religious groups in the country: Orthodox Christians, Protestants, Muslims, and others (i.e. Catholics and traditional faiths).

The results from the econometric analyses employed to answer this research question (see Chapter 3) reveal the importance of the density of Orthodox Christians in localities, with stronger impacts observed on milk consumption and milk acquisition in dominantly Orthodox localities. We therefore focus for the remaining two research questions on two milk sheds that host an Orthodox majority, i.e. the Great Addis milk shed with 75% Orthodox Christians and the Mekelle milk shed where over 95% of the population adheres to the Orthodox faith. In dominantly Orthodox settings, most of the milk producing households will be Orthodox Christian, which implies that these households will be affected twice by fasting spells: (1) they reduce their own milk intake during fasting which creates excess milk, and (2) due to reduced milk demand during fasting periods in these dominantly Orthodox settings, milk producing households will have less market outlets to sell their milk too.

4.2. Research question 2

To investigate how religion affects milk production and output use, we focus on dairy farming households in two different milk sheds in Ethiopia that host an Orthodox majority: the Great Addis milk shed and the Mekelle milk shed. We specifically focus on commercially-oriented dairy farming households that primarily produce for the market, while surplus milk is used for own consumption. The interviews in the Great Addis milk shed were carried out by a programme led by IFPRI, while the ones in Mekelle originate from own fieldwork. Each of these chapters casts a different light on how milk producing households have adapted to a context of (expected) milk demand seasonality caused by Orthodox fasting practices.

In Great Addis milk shed, a total of 870 milk producing households were interviewed: 30 urban, 240 peri-urban, and 600 rural farms. This data collection round was part of the project “Improving the evidence and policies for better performing livestock systems in Ethiopia” lead by IFPRI as part of the Feed the Future Innovation Lab for Livestock Systems. Interviews were conducted in January-February 2018. The survey assembled data on milk production, processing, and sales in the month prior to the interview. This past month coincided partially with either the Lent fast or the Advent fast, a 40-day fast preceding Christmas. The survey also covered household milk consumption in the week prior to the interview with separate data for milk intake of the youngest child within these households. The recall period of these data again partially overlaps with the Orthodox Lent fasting period, as was the case in the third chapter. We single out the impact of a long fasting period on milk production using an Ordinary Least Square approach, while the impact of fasting on output use (how much of the produced milk is processing, sold, consumed and given out) and volumes of sales and consumption is detailed using Seemingly Unrelated Regression Equations. We detail consumption volumes not only at household level, but also for the youngest child in the household separately, using an Ordinary Least Squares regression. Including the impact of fasting on the milk intake of young children is relatively new, and not well studied so far. While children below the age of seven are officially exempt from fasting, the few studies that have been performed, found negative effects of Orthodox fasting on children’s milk intake [213, 214]. We extend our analyses by exploring potential heterogeneity in the way dairy farming households have adapted to a context of fasting. Since the interviewed households were located at different distances from the capital Addis Ababa, we use the travel time needed to reach the capital to proxy market accessibility assuming that households located closer to the capital have better access to the market.

In a fifth chapter, we investigate how urban dairy holders within the Mekelle milk shed have adapted to a context of Orthodox fasting. We sampled 304 dairy farming households in Mekelle city, the centre of the milk shed. Dairy farms in this urban centre are the most market-oriented and therefore the most interesting in order to study how fasting affects milk sales. Contrary to dairy farmers in the

Addis milk shed, little is known about the producers that operate within Mekelle city. The objective of this chapter was thus twofold: gaining insight in the diversity of urban milk production systems and exploring how these production systems have evolved within an almost exclusively Orthodox locality. In this chapter, we sketch who engages in urban dairy farming, how urban production systems are managed, how productive and profitable these systems are, and what kind of interventions would benefit the development of these systems. Therefore, we cluster urban producers along three dimensions: input efficiency, market integration, and resilience towards demand seasonality caused by Orthodox fasting.

4.3. Research question 3

Finally, to investigate whether religion plays a role in milk market exchanges, we conducted a series of experimental choice tasks with both milk consumers (Chapter 6) and milk producers (Chapter 7) in Mekelle city.

For consumers, who purchase milk from the market, we constructed potential milk seller profiles that included five relevant attributes: temporal distance to the selling point, type of supplier (producer or milk shop), gender and religious affiliation of the supplier. In a series of choice tasks, we asked producers to choose among three seller profiles. Religious affiliation in these choice tasks was signalled via names or religious symbols.

We constructed a quasi-identical choice experiment for milk producers, in which we profiled potential milk buyers using the following attributes: milk price, payment terms (payment on the spot or delayed), type of buyer (individual consumer, trader, or milk shop), gender and religious affiliation of the buyer.

5. Dissertation structure

The core of this dissertation consists of the five chapters unpacked in the Sections 3 and 4 of this Introduction chapter. Before turning to the five chapters, a contextual background is given in Chapter 2 so as to cast light on the religious landscape in Ethiopia, Orthodox fasting practices, as well as on the country's milk system. Additionally, this contextual background chapter provides more information on the two selected milk sheds and milk chain actors investigated within this dissertation. The following chapters, Chapters 3 to 5, answer the first two research questions and Chapter 6 and 7 provide answers to the third research question.

The chapters answering the research questions are presented in their original format as published or submitted for publication. While reading the manuscript, the reader will thus encounter overlap in the literature, research context, and data collection sections of the chapters. We prefer to stay close to the original papers, to keep the chapters as stand-alone reading material.

At the end of this dissertation, we will summarize the overall conclusions of the different chapters and highlight how these answer our three research questions. We will ponder on the contribution of this dissertation to academic literature, the implications of our research findings and we will formulate some policy recommendations. We conclude this dissertation by putting forward future directions for research.

CHAPTER 2

Contextual background

Ethiopia is a landlocked country in the Horn of Africa bordering Eritrea, Somalia, Kenya, South Sudan and Sudan (Figure 2-1). Ethiopia inhabits the second biggest population (109 million in 2018) of Africa after Nigeria [215]. Its population is still growing fast at 2.7% annually in 2018, with its urban population growing even faster, i.e. 4.8% in 2018. Ethiopia is among the top ten of fastest urbanizing countries in the world [215]. The country's economy is rapidly expanding with average growth rates in Gross Domestic Product of 9.9% a year in the period 2007/08 to 2017/18. This economic growth increases purchasing power, and trends in the Gross National Income follow those of the Gross Domestic Product. Still, the country remains one of the poorest in Africa. Annual income per person only reached 790 dollar in 2018, half of the SSA average that year [216].



Figure 2-1: Geographical location of Ethiopia in the African continent

Note: figure created with Mapchart.net

1. Sketching Ethiopia's religious landscape

1.1. A rich Orthodox Christian and Islamic tradition

As early as the fourth century, an Aksum king converted to Orthodox Christianity along with his people, which signalled the start of a very strong Ethiopian connection to the Orthodox Church [217]. Only three centuries later (in 615), Prophet Muhammad's first followers immigrated to Ethiopia, and Islam mainly spread via trade routes to lowland coastal areas inhabited by pastoralists and the Somali and Afar regions [64, 218, 219]. Other Christian beliefs, particularly Protestantism, were introduced by foreign missionaries as was the case in other African countries, mainly converting those adhering to traditional faiths in the southern and western regions [220].

For a long time, Orthodox Christianity was privileged over other religions in the country because of its official status as state religion, and several Ethiopian emperors attempted to ban the practice of Islam and to enforce mass conversion to Orthodox Christianity. The Islamic community has stayed within the margins of political life for centuries, contributing to the rivalry between Islam and Orthodox Christianity in the country [221]. Only in 1995, Ethiopia became a secular state by law with freedom of religious choice where religious discrimination is prohibited. Yet, religious tensions are still widely prevalent in the country [222, 223].

As in the rest of SSA, Christianity and Islam are the two dominant religious groups in the country [224], with Christians representing 64% of the Ethiopian population and Muslims 34%. Only 3% of the population adheres to traditional faiths. Ethiopia's population is highly religious. 98% of the population values religion as very important in their daily lives, 82% attends religious services at least weekly, and 65% prays daily. No age gap is observed in either of these measures implying that young people are as religious as older people [29].

Christians form a majority in most Ethiopian regions, except for the Afar, Somali, Dire Dawa and Harari region in the eastern part of the country (Figure 2-2). In the Benishangul-Gumuz and Oromia region, Muslims and Christians are equally present.

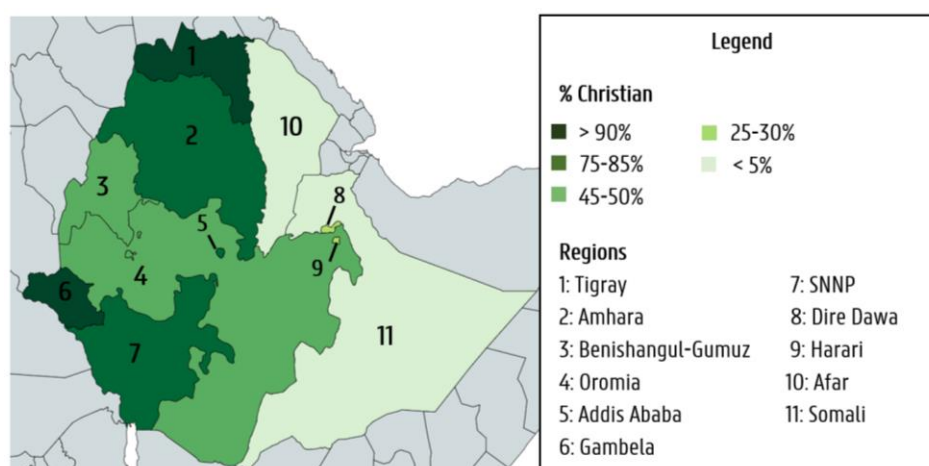


Figure 2-2: Christian-Muslim representation in Ethiopia based on census data 2007

Note: figure created with Mapchart.net

Most Christians in Ethiopia affiliate to the Orthodox Church (representing 71% of all Christians). Catholics and Protestants account for 1% and 27% of the Christian community respectively [225]. The country hosts the second largest community of Orthodox Christians in the world after Russia⁴. Orthodox Ethiopians are part of the Oriental branch of Orthodox Christianity, along with the Oriental Orthodox Churches in Egypt, India, Armenia, Syria and Eritrea. Orthodox Ethiopians, who constitute 14% of the global Orthodox population, are much more religiously observant than are their counterparts in Central and Eastern Europe and the United States. For example, 78% of Orthodox Ethiopians say they attend church at least weekly, compared with a median of 10% and 31% of Orthodox Christians in Europe and the United States, respectively. Moreover, 98% of Orthodox Ethiopians say religion is very important to them in their daily lives, compared with 52% and 28% of Orthodox Christian in the United States and Europe, respectively [32].

Orthodox Christians are largely concentrated in the Tigray (>95% of the population), Amhara and Addis Ababa regions (between 75%-85% of the population) (Figure 2-3). The limited spread of Orthodox Christianity in the southern part of the country, and notably in the Afar and Somali regions, has been attributed to different livelihoods, with many people depending on animal husbandry in both regions, where a ban on the consumption of ASFs for about half a year is a major barrier to become Orthodox Christian [226]. Overall, urban areas host more Orthodox Christians (59% of its population is Orthodox versus 40% in rural areas), while rural areas are inhabited by more Muslims (35% versus 26% in urban areas) [15].

⁴ Three-quarters of the world's Orthodox population lives in Central and Eastern Europe, where they make up about 57% of the region's population. These Orthodox Christians affiliate to the Eastern branch of Orthodox Christianity. Most Other Orthodox Christians live in the Middle East and Africa, notably Ethiopia and Egypt [32].

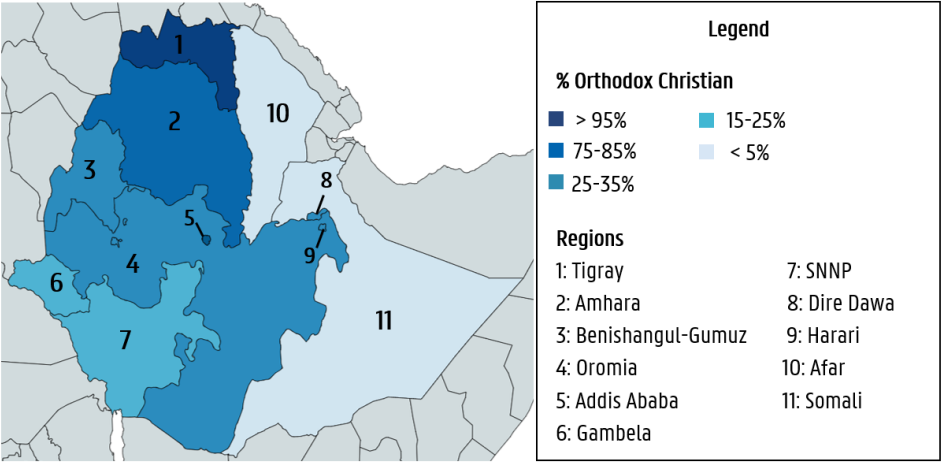


Figure 2-3: Orthodox Christian representation in Ethiopia based on census data 2007
Note: figure created with Mapchart.net

1.2. Orthodox fasting practices

Both the Orthodox and Islamic traditions prescribe fasting practices to their followers. Protestants, conversely, do not have specific regulations on fasting. The major fasting period in the Islamic faith is the Ramadan, which lasts 28 to 30 days. During this holy month, Muslims should refrain from food and drinks from dawn to sunset [227]. This fasting interpretation differs greatly from the Orthodox Christian church, where fasting refers to abstinence from ASFs during several official fasting periods, spread throughout the year. This means that during those periods, no consumption of meat, eggs, or milk is allowed. Fasting spells consist of one-day fasts and longer fasting seasons, covering multiple days or weeks, often preceding holy events. An overview of the compulsory fasts in the Ethiopian Orthodox Christian church is given in Table 2-1. Fasting rules are strict, but pregnant and lactating women, severely ill or weak persons, as well as children below the age of seven are fully exempt from fasting [78]. In addition to these commonly imposed fasts, a large variety of spontaneous individual fasts is applied, making it difficult to assess the exact number of fasting days. Yet, it has been estimated that the total number of fasting days amounts to 166-250 days a year [8, 16, 17]. Fasting is seen as an integral part of the Orthodox identity and serves as a measure of devoutness [78].

Table 2-1: Overview of the obligatory fasting events and feasts in Ethiopia according to the Orthodox Church doctrine (based on Knutsson and Selinus [78], Ware [228], and The Ethiopian Orthodox Tewahedo Church [229])

Fasts	Timing	Feasts	Timing
		New Year	September 11
		Meskel	September 28
Advent fast	40 days, from November 28 – January 6	Christmas	January 7
Epiphany fast	Fast on the eve of Epiphany	Epiphany	January 19
Nineveh fast	Three days (Monday to Wednesday), two weeks before the start of Lent		
Lent fast (Easter fast)	55 days, starts on Monday, movable start (between February 8 – March 14)	Easter	Movable date (between April 4 – May 5), always on Sunday
		Ascension	Movable date (40 th day after Easter, between May 13 – June 16), always on Thursday
		Pentecost	Movable date (between May 23 – June 26), always on Sunday
Sene fast (Apostles fast)	10-40 days, starts Monday after Pentecost and ends July 12	Feast of the Apostles	July 12
Felseta fast (Assumption fast)	15 days, from August 7 – August 21	Assumption feast	August 22
Weekly fasting	Every Wednesday and Friday (except for the period between Easter and Pentecost)		

2. Unpacking the Ethiopian milk system

The Ethiopian milk system is predominantly traditional, with milk being mainly sourced from home production or purchased from informal markets with short supply channels. Different actors operate within this system, notably the milk producers and milk consumers [194]. Yet, some milk sheds, especially the one located close to the capital, Addis Ababa, are rapidly transforming, where informal and formal markets start to co-exist. In what follows, we will detail current milk production systems, milk processing and marketing, and milk consumption patterns.

2.1. Milk production

Livestock, and especially cattle, are an important backbone of the Ethiopian economy, and almost all Ethiopian farms hold some livestock. Cattle account for three-quarters of the total value of the livestock stock. It is estimated that about 70% of the households in Ethiopia keep cattle with cattle serving different functions: they are a source of income, food, they serve as draft power, a source of insurance and savings, a form of social capital, but they also deliver other goods besides milk (e.g. manure, hides) [37]⁵. Recent figures estimate the annual national milk production at 5.2 billion L. About 80% of this milk is produced by cows and the remaining 20% is camel milk. Goat milk only represents a marginal share of the total annual milk production (i.e. 152 million L/year) [230]. Throughout this dissertation we will only focus on the cow milk value chain.

While Ethiopia has the fifth largest cattle herd of the world (estimated at 57.8 million head of cattle) and favourable agro-ecological conditions for cattle rearing (especially in the highlands), milk productivity, defined as the output per animal, is extremely low in the country as compared to its nearby countries [230, 231]. The latest figures show that the average annual milk yield per cow was 261 kg in 2017, while productivity was 36%-50% higher in Somalia, Sudan, and South Sudan, and 127% higher in Kenya [232]. Furthermore, milk productivity levels have been stagnant in the last decade, while milk output grew significantly over the past 15 years, with approximately 50%. The latter can be attributed to a growing cattle stock and number of cattle farmers [231].

Most cows are reared in the central highlands of the Tigray, Amhara, Oromia and SNNP regions, which cover 11% of Ethiopia's landmass. Moreover, half of the cattle stock is raised within a 10 km radius from major livestock markets and all-weather roads as can be seen from Figure 2-4 [233].

⁵ In the LSMS data we used in this dissertation, we found that for the households who reported to own cattle, half of them indicated they owned dairy cows that gave milk in the past year.

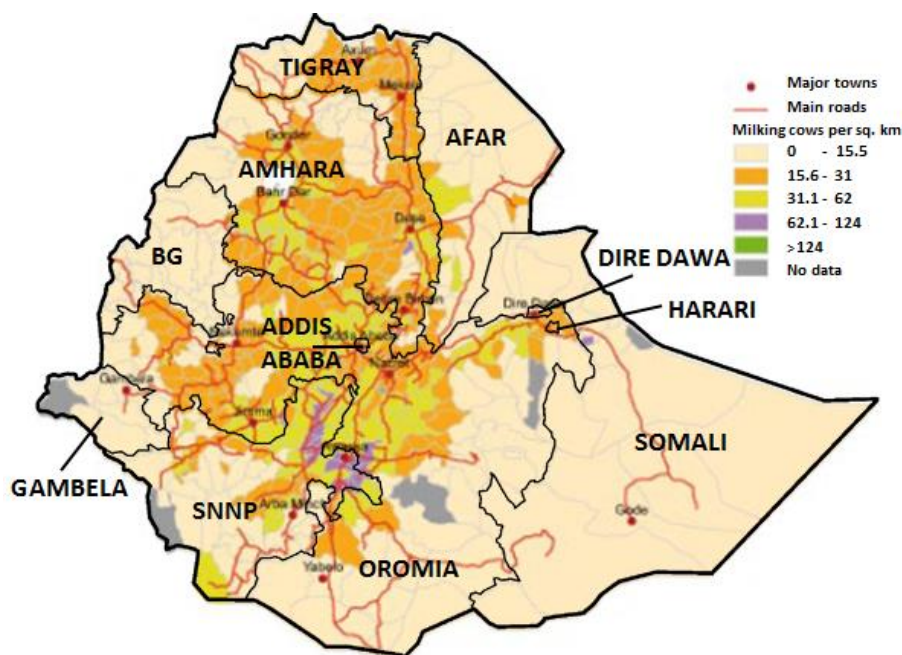


Figure 2-4: Milking cow density in Ethiopia (number per square kilometre) (adapted from Jabbar et al. [234])

Most milk in the country is produced by smallholder farmers, and 95% of the farms have less than five head of cattle [201]. Cattle are raised in three different production systems: pastoral and agropastoral grazing systems in the Ethiopian lowland, mixed livestock-crop production systems in the highlands where cattle are important for traction and manure, and specialized production systems (smallholders and commercial farms) in and around Addis Ababa and other regional capitals. Most cattle are local breeds, and only 1.6% and 0.2% are hybrid and exotic breeds respectively [235]. These hybrid and exotic breeds are kept in specialized production systems that almost exclusively rely on feed procurement outside the farm [230].

Mixed production systems are the most important systems in terms of head of cattle (70% of total cattle herd) as well as milk output (67% of total annual milk production), lowland grazing comes second (28% of the cattle and 20% of milk output) and specialized production units are still relatively scarce, housing 3% of all cattle in the country, yet producing 12% of total milk output. The latter can be explained by the higher milk productivity in these specialized units reaching 3050 L/lactation and 2150 L/lactation in medium and small specialized farms respectively compared to 256 L/lactation in the grazing system and 464 L/lactation in the mixed system [230]. The low productivity of the mixed production and lowland grazing systems limits the amount of excess milk left to market, which contributes to the low commercialization level of the traditional production systems. The milk demand seasonality caused by Orthodox fasting practices reduces commercialization incentives even further [16].

2.2. Milk processing and marketing

Zijlstra et al. [201] estimated that of the total national milk production, 68% is used for human consumption (Figure 2-5). Post-harvest losses of milk are low, only 3.4%, because of the rather short supply channels [230]. Producing households mostly consume the milk at home and process it to butter, yoghurt, or cheese. Only 6.6% of the produced milk intended for human consumption ends up directly in the market in its liquid form. Yet, producing households also sell part of milk indirectly in the form of self-processed milk, especially butter and cheese (with 14.4% and 36.6% of the total production of these products being sold respectively) [201]. Market orientation varies across production systems with rural systems mainly producing for home consumption and farms in (peri-) urban areas selling three-quarters of their produced milk [12].

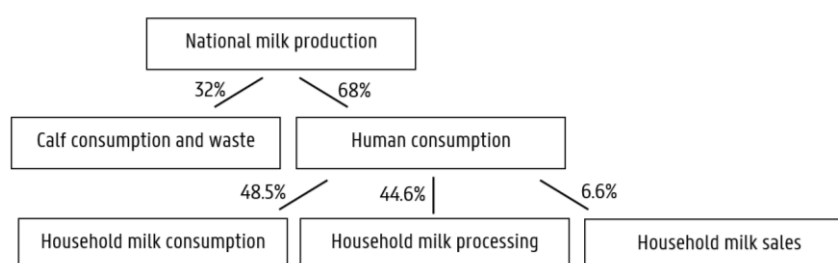


Figure 2-5: Usage of the produced milk in Ethiopia (adapted from Zijlstra et al. [201])

Traditional or home processing is often done by women using traditional methods and starts from fermented milk. Milk is left to ferment for 3-5 days. This fermented milk, *ergo*, which is semi-solid and therefore resembles yoghurt, can be processed further into butter, *kibe*, and buttermilk (the residual liquid after butter production). The buttermilk can be converted into a local soft cottage cheese, known as *ayib*. The traditional processing is labour-intensive and rather inefficient; 16.5 L of milk is needed to produce 1 kg of butter [13, 236].

Industrial processing is not widespread (an estimated 40 plants operate in the country) and is mainly concentrated around the capital Addis Ababa. These industrial plants produce pasteurized milk, butter, cheese, and yoghurt. Most plants still operate below capacity. The lack of technical know-how and proper equipment, insufficient milk supply, and Orthodox fasting constrain the further industrialization of milk processing. Most processors indicate that the lack of supply of raw milk is the most important for their sub-optimal performance, while on the other hand many dairy farmers perceive that (1) there is a lack of demand which makes them reluctant to invest in milk production and (2) their cost price is higher than the market price [201].

Liquid milk and traditional fermented butter are the main commodities entering the Ethiopian milk market. 17% of the national milk production is processed to butter resulting in the production of 51.2 million kg of butter, of which 2% is lost post-harvest. Traditional fermented butter processed by

smallholder producers is mostly traded informally in rural areas [230, 236]. Limited market accessibility in remote areas makes it more attractive to process milk into butter, since butter has a longer shelf life. Marketing of liquid milk is therefore often restricted to peri-urban and urban areas.

Liquid milk reaches the end consumer through six different sub-chains, of which two are formal (Figure 2-6). The formal chains market pasteurized milk, while in the informal sub-chains raw or unpasteurized milk is traded [230]. 10.8 million L of pasteurized milk reaches end consumers of which 38% flows directly from processors to consumers. 367.8 million L milk is marketed through the four informal channels, 49% being traded directly from producers to consumers, 30% channels from producers to food service providers (FSPs) i.e. milk shops, cafés, restaurants, and hotels, to consumers, and the remaining 21% from producers to traders, who either directly sell to consumers or sell to FSPs. Smallholders in the lowland grazing system mainly sell their milk to milk traders, while farms in the mixed system sell to both traders and processors. Specialized production units on the other hand sell mostly to processors and FSPs [230].

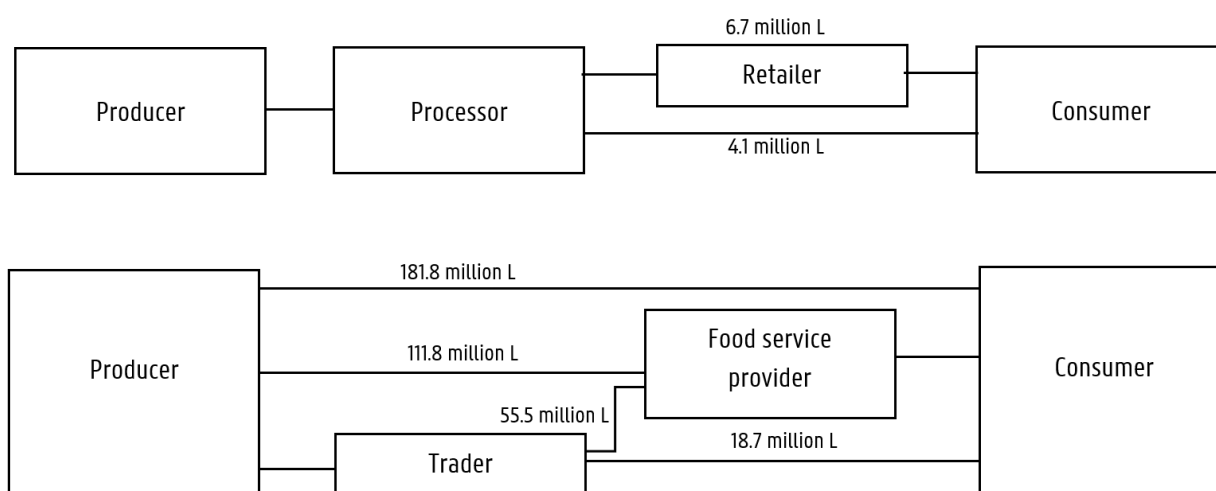


Figure 2-6: Graphical representation of the formal pasteurized milk (top) and the informal raw milk sub-chains (bottom)

2.3. Milk consumption and prices

Rising incomes and urbanization are shifting Ethiopian diets towards the inclusion of high-value products such as ASFs [237]. Yet, total ASF intake is still low in Ethiopia and remains rather stagnant. The total volume consumed per capita only increased by 1.1 kg between 2005 and 2011, and is currently assessed at 20.6 kg per adult equivalent per year of which 14.7 kg is milk (both liquid and processed) [8]. Milk intake in the country is only half of the sub-Saharan African average [9]. The food-based dietary guidelines for healthy diets prescribe an average daily consumption of 250 mL of liquid milk for adults (and 500 mL and 600 mL for children and adolescents respectively), which equals a yearly consumption of minimum 90 L per capita (249). Ethiopia's per capita milk intake thus falls short of the prescribed intake by more than four-fifth. Problems of structural supply, poorly developed local markets, low purchasing power, high prices, Orthodox fasting practices, and lack of consumer awareness regarding the nutritional benefits of ASFs have been advanced to explain low consumption levels [11-14].

Not only is the contribution of ASFs to total energy intake low (1.7% and 3% in rural and urban diets respectively [238]), consumption is also subject to significant seasonal fluctuations, mainly caused by religious fasting (Figure 2-7). Intake drops during the main Orthodox fasting months in March and December, while consumption peaks are observed during religious festivities (notably, for Easter in April and New Year and Meskel in September, and to a lesser extent Christmas in January) (see Table 2-1) [17]. Per capita calorie intake fluctuates much more among urban households as compared to rural households and urban households consume significantly more ASFs during religious festivities. Per capita consumption of ASFs in urban areas is almost twice as high as the consumption in rural areas, which is linked to income differences and the resulting changes in household preferences as increasing income levels have been associated with a shift from diets dominated by starchy staples to diets that increasingly include ASFs (Bennett's law) [8].

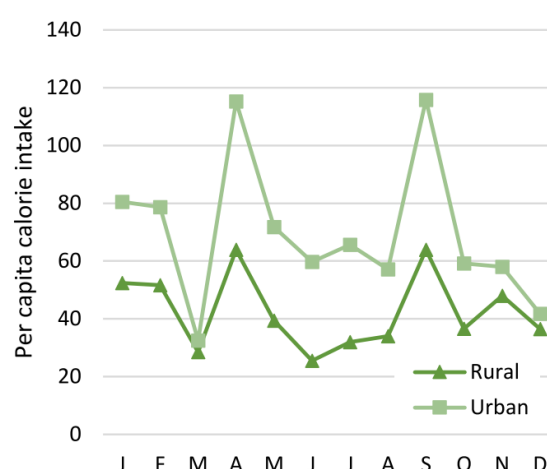


Figure 2-7: Consumption of animal-source foods in Ethiopia by month
(Source: Bachewe et al. [17])

Low prices and income increases could improve consumption of milk, but also other ASFs, in Ethiopia significantly [8]. The income elasticity of milk has been estimated at 1.8 [239], which implies that any increase in household income leads to a bigger increase in milk consumption. Milk can therefore be considered as a luxury good, that is increasingly consumed by the better-off households. Detailing milk consumption by income group shows that fewer households consume milk and milk products in the poorest quintile, only 30%, while up to 57% of the households consume milk in the richest quintile. Average per capita intake of milk is about 300 g each week in the poorest quintile and reaches nearly 800 g per week in the richest quintile. Moreover, households in the richest quintile source the majority (three-quarters) of their consumed milk from purchase and only one quarter from own production. Households in the poorest quintile on the other hand source about two-thirds from own production. Increasing income thus rises milk consumption levels and decreases the share of milk consumed from own production [37].

Although per capita income levels have been increasing in Ethiopia, total intake volumes of ASFs did not. Yet, annual per capita expenditure on animal protein has increased rapidly in the country, by 50% between 1996 and 2011 [8]. The increasing prices of ASFs explain this trend, which we detail more below. ASF expenditure patterns vary greatly along the rural-urban divide as well as along wealth quintiles. Urban households and households in the richest quintile spend twice and ten times as much on ASFs compared to rural and the poorest households respectively [8]. The food budget share spent on ASFs does not differ significantly between urban and rural households (13.6% and 10.5% respectively), while in the richest households this share is three times higher than in the poorest households (16.5% versus 4.9%). High prices limit the affordability of ASF products for non-producing households and explain why only the relatively better-off non-producing households can afford to consume these products regularly, who are mainly found in urban areas [240].

The price elasticity of milk at a national level is close to -0.5, which implies that a doubling of prices reduces milk consumption by almost half (in urban areas, this elasticity rises even to -1.1) [17]. Prices differ among different milk products with unpasteurized milk being the cheapest milk product in the country. The price of yoghurt is about 65% higher than that of unpasteurized milk, while pasteurized milk and cheese are twice as expensive as unpasteurized milk. Butter is the most expensive milk product in the country and its price is ten-fold that of unpasteurized milk [17].

Prices of liquid and processed milk have been rising greatly over the past decade (Table 2-2). Urban retail prices of unpasteurized milk have increased by 36% since 2007. Also, for other milk products, urban retail prices rose by about 20%. Rural producers' prices for unpasteurized milk and cheese rose even faster, by 41% and 46% respectively between 2007-2016. This makes milk, and other ASFs, expensive products in Ethiopia, which cost on average ten times as much per calorie and per kg than cereals [17].

Table 2-2: Price evolution of liquid and processed milk in Ethiopia (source: Bachewe et al. [17])

	Urban retail prices			Rural producer prices		
	2007	2011	2016	2007	2011	2016
Median real prices (2011 ETB)						
Unpasteurized milk (ETB/L)	7	9	10	6	7	8
Pasteurized milk (ETB/L)	14	17	17	-	-	-
Yoghurt (ETB/kg)	13	15	16	-	-	-
Cheese (ETB/kg)	18	18	22	15	16	22
Butter (ETB/kg)	83	101	100	71	82	85
Comparison with national median in 2007 (%)						
Unpasteurized milk (%)	-	118	136	-	130	141
Pasteurized milk (%)	-	122	122	-	-	-
Yoghurt (%)	-	115	122	-	-	-
Cheese (%)	-	101	125	-	105	146
Butter (%)	-	122	120	-	116	120

Not only have prices been rising over the past year, also within a year prices fluctuate greatly. These price fluctuations are driven by seasonal changes in demand for milk as well as supply. The periodic occurrence of Orthodox fasting and feasts makes milk demand vary, while the annual rainfall pattern affects milk supply due to its impact on feed availability and milk yields. Figure 2-8 outlines the rainfall pattern and associated agricultural seasons as well as timing of the main Orthodox fasts and feasts throughout the year.

Bachewe et al. [17] studied price data collected within a consumer price survey from the Central Statistical Agency of Ethiopia. The survey collected prices of 116 urban retail markets from traders, retailers, and consumers in all regions of Ethiopia between January 2007 and December 2016. They report that market prices for liquid and processed milk are low during periods of abundant supply (from the summer until the end of the year⁶) and low demand (the Advent and Lent fasting periods). Conversely, prices are at their highest level when high demand (feasts like Christmas and Easter) interacts with a declining availability of milk (in the beginning of the year)⁷. Price fluctuations are most outspoken for butter and, to a lesser extent, for cheese. Liquid milk and yoghurt prices seem to be barely affected by seasonality in milk supply or demand (Table 2-3). Important to keep in mind is that the prices reported in Table 2-3 are averages over the country. We however expect different local patterns of demand and supply and thus divergent local price fluctuations since markets in Ethiopia are highly fragmented.

⁶ Except for the month of September when prices increase because of New year and Meskel.

⁷ Prices, however, drop again during the Orthodox Lent fasting period in March.

Table 2-3: Seasonal price indices of liquid and processed milk in Ethiopia, 2007-2016 (source: Bachewe et al. [17])

	Milk	Yoghurt	Cheese	Butter
January	1.00	1.00	1.02	0.97
February	1.00	1.00	1.02	0.96
March	1.00	1.00	0.97	0.99
April	1.00	0.99	1.00	1.11
May	1.00	1.00	1.05	1.11
June	1.00	1.00	1.03	1.05
July	1.00	1.00	0.98	0.99
August	1.00	1.00	0.98	0.98
September	1.00	1.00	1.02	1.01
October	1.00	1.00	0.99	0.95
November	1.00	0.99	0.98	0.93
December	0.99	1.00	0.95	0.93
Amplitude	0.01	0.01	0.09	0.18

Note: Seasonal price indices were calculated using the percentage moving average method. First, a twelve-month moving average of the real price for each item was calculated. Then the price series so constructed are normalized by dividing it to its January 2007 values. Accordingly, the price index has a value of one in January 2007 and it is greater/less than one in months with de-seasonalized prices greater/less than January 2007 prices [17].

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.		
Rainfall pattern		Dry period				Summer rains								
Agricultural seasons						Lean season					Main harvest season			
Orthodox fasts and feasts	1	2	3	4		5	6	7	8	9	10	11	12	13

Figure 2-8: Visual representation of the rainfall pattern, agricultural seasons and timing of the main Orthodox fasts and feasts throughout a year

Note: (1) Christmas, (2) Epiphany, (3) Nineveh fast, (4) Lent fast, (5) Easter, (6) Ascension, (7) Pentecost, (8) Apostles fast, (9) feast of the Apostles, (10) Felseta fast, (11) Assumption feast, (12) Ethiopian New Year, (13) Advent fast

Besides these temporal price fluctuations, prices also have spatial patterns and vary significantly across regions (Table 2-4). Prices of liquid and processed milk are the lowest in Benishangul-Gumuz, as well as other western regions in the country, i.e. the Gambella region and the Southern Nations, Nationalities and Peoples' region (SNNP), followed by Amhara and Oromiya regions. Liquid and processed milk prices are on the other hand very high in the Harari and Dire Dawa regions, as well as the Somali and Afar regions to some extent. Prices in the Addis Ababa region are also high, except for pasteurized milk, due to its better developed formal processing infrastructure, and yoghurt. In general, prices are higher in cities [17].

Table 2-4: Prices in Ethiopian ETB (ETB) for liquid and processed milk by region, 2007-2016 (source: Bachewe et al. [17])

	Tigray	Afar	Amhara	Oromiya	Somali	Benishangul-Gumuz	SNNP	Gambella	Harari	Addis Ababa	Dire Dawa
Unpasteurized milk (ETB/L)	9	11	8	9	11	8	9	8	12	11	12
Pasteurized milk (ETB/L)	21	25	15	18	25	15	18	17	24	16	23
Yoghurt (ETB/L)	22	15	13	16	18	15	15	19	18	13	15
Cheese (ETB/kg)	24	32	21	19	23	6	19	21	47	39	50
Butter (ETB/kg)	105	109	90	96	109	74	96	98	116	113	107

Note: 1 USD= 17.2 ETB

Key figures of the Ethiopian milk system

- 4.16 billion cow milk is produced each year
- Milk productivity in the country is extremely low as compared to neighbouring countries
- 95% of the milk is produced by small-scale farmers owning less than five head of cattle
- 3% of the milk is produced in specialized dairy units, located in (peri-)urban areas
- 68% of the produced milk nationally is used for human consumption
- Of the milk used for human consumption, 48.5% is consumed by milk producing households, 44.6% is processed and only 6.6% of the produced milk is sold as such
- In (peri-)urban areas, milk producers sell at least 75% of their produced milk
- 78% of the marketed milk ends up in informal channels
- 49% of the milk traded in informal channels is sold directly from producers to consumers, while 45% passes through FSPs
- Intake of milk is low and estimated at 14.7 kg/capita/year

3. The Great Addis and Mekelle milk sheds: A descriptive glimpse of our two dominantly Orthodox study areas

Nine major milk production areas, so called milk sheds, can be distinguished in Ethiopia (Figure 2-9). In this dissertation, we focus on two: the Great Addis (Chapter 4) and Mekelle milk shed (Chapter 5, 6, and 7), that both host an Orthodox majority (Figure 2-3). The milk sheds we study are located close to the cities of Addis Ababa and Mekelle, the first and third largest city in the country respectively. Addis Ababa, the capital city, is home to about 4 million citizens [201], while Mekelle city – the capital of the northern Tigray region – is one of the fastest growing urban areas in the country, inhabiting a bit more than 400,000 people [241]. Compared to other milk production areas situated in the central highlands of Ethiopia, especially the Great Addis milk shed, the Mekelle milk shed has received far less scholarly attention.

Before turning to core of this dissertation, we would like to give some descriptive information on these two study areas. We do so specifically for the milk producing households interviewed by IFPRI of whom we use the secondary data in Chapter 4. For the Mekelle milk shed, we provide details on urban milk producing households, as well as two other important actors in the urban milk chain we interviewed during our own fieldwork data collection rounds in Mekelle city: i.e. milk shops, an increasingly important FSP, and urban milk consumers.

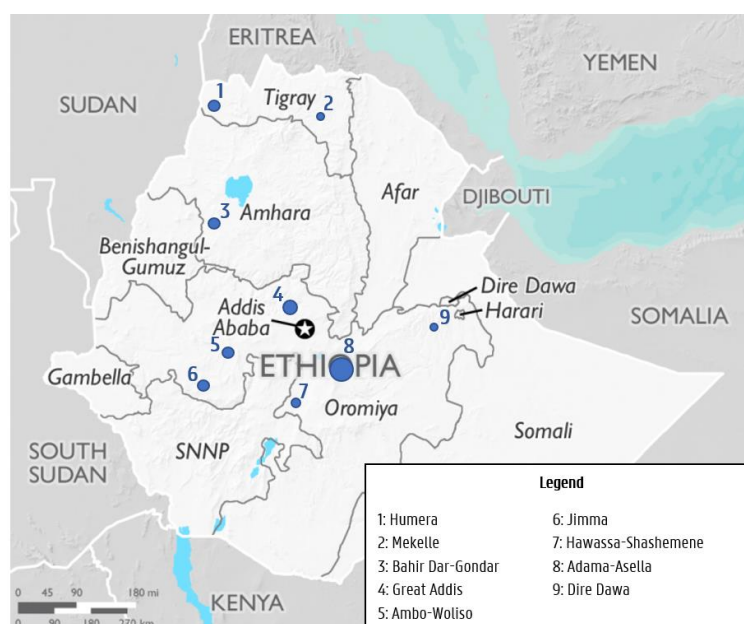


Figure 2-9: Geographical location of the nine major milk sheds in Ethiopia

Note: image source: USAID [242], adaptations based on Zijlstra et al. [201].

Bigger dots represent more important milk sheds in terms of their contribution to the total national milk output

3.1. Milk producing households in the Great Addis milk shed

Annual consumption of milk significantly increased – by 31% – in the last decade in the metropolitan area of Addis Ababa because of income and population growth. Still, intake per adult equivalent of liquid milk and milk products remains low: 8.5 litres and 10.2 kg, respectively. The milk shed has witnessed a rapid rise in the number of milk processing firms – their number tripled over the last decade, from 8 to 25 plants – and an increasing number of traders operate today within the rural-urban interface. In the period 2016/17, almost 200,000 litres of milk were processed every day. Yet, significant concentration exists in the processing sector with four firms supplying three-quarters of all the pasteurized milk products in the market. Moreover, over 40% of the processing capacity is still not used. Most commercial farms, as well as milk processing industries are located in this milk shed, and the production of processed milk amounts to about half of the yearly production of raw milk. Yet, the informal dairy sector remains important and acts as an important buffer when there is an oversupply of milk during long Orthodox fasting periods [243].

In what follows, some key figures and characteristics are summarized of the dairy producers that were interviewed by IFPRI as part of the research project ‘Improving the evidence and policies for better performing livestock systems in Ethiopia’. The research project covered rural producers in the two major milk production zones, North and West Shewa, suburban producers and producers within the capital city Addis Ababa. The data presented are a summary of the data included in the Ethiopia Strategy Support Program working paper written by Minten et al. [244].

Smallholder dairy farms are the most important suppliers of milk to the capital, supplying 89% of all the milk. According to official records, 52% of the households in the two rural zones own dairy cows, while 34% and 0.1% of the households are engaged in dairy farming in suburban and urban Addis respectively. The total number of dairy cows in the three areas is estimated at 1,419,000 heads – 1,030,000 in the two rural zones, 360,000 in suburban Addis and 29,000 in the city of Addis Ababa. The 29,000 heads of dairy cows supply 31% of the total urban liquid milk and the suburban and rural areas make up 31% and 37% of the overall liquid milk market, respectively. Urban dairy farms thus remain important, also in Addis Ababa.

Milk yields vary significantly with urban dairy farming households achieving three- to two-fold the yields of rural and suburban producers respectively. Milk yields are higher for farmers in well-connected areas with transport links to Addis Ababa, who increasingly adopt cross-bred cows and commercial feeds, and who benefit from better access to services (health and extension). Still, the adoption of cross-bred cows remains limited, especially in rural and suburban areas. This may be attributed to differential access to artificial insemination, high costs of acquisition and maintenance of cross-bred cows, high risks associated with these cows (i.e. vulnerability to diseases and climatic shocks).

Dairy producers get increasingly market-oriented and less than one-quarter of the produced milk on the farm is used for own consumption – in urban households this drops to 11%. Dairy producers in these two zones thus mainly produce for the market, and remaining milk is used to satisfy own household needs. Milk supply in rural and suburban areas has been rising over the last decade with 13% and 19% of the rural and suburban households currently selling liquid milk on the market. Still, products sold by producing households differ significantly with urban farmers specializing in liquid milk sales, while rural and urban households still sell a significant share of processed milk products. Traders are the main buyers for most rural and suburban buyers, while urban producers mostly sell directly to consumers.

Table 2-5: Main descriptive statistics of the interviewed milk producing households in the Great Addis milk shed by IFPRI (Source: Minten et al. [244])

	Unit	Producing households		
		Rural	Suburban	Urban
Dairy cows	#	1.8	2.0	5.3
Farms that have cross-bred cows	%	27.0	26.6	97.9
Milk yield	L/day/cow	3.3	4.8	9.9
Dairy farms selling liquid milk	%	13.3	19.2	95.6
<i>Of total liquid milk produced during a non-fasting period:</i>				
Used for own-consumption	%	21.2	24.5	11.1
Sales of liquid milk	%	11.0	16.8	82.6
Processed milk	%	67.1	57.7	4.9
Given out	%	0.7	1.0	1.4
Spoiled	%	0.1	0.0	0.1
Butter, average share of sales during non-fasting period	%	42.0	34.9	0.0
<i>Farms reporting as main buyer:</i>				
Consumer	%	11.2	21.0	66.9
Processing company	%	22.1	20.0	18.2
Trader	%	65.7	52.9	0.7

3.2. Important actors in the milk value chain of Mekelle city

Since the Mekelle milk shed has received far less scholarly attention as compared to the Great Addis milk shed, no accurate figures are available on milk consumption patterns in this area, as well as the total dairy cow herd and production output. Official records cite 12,600 milking cows in the city of Mekelle [245], while figures of the surrounding peri-urban and rural areas are incomplete. Yet, it is believed that most of the dairy cow population of the Mekelle milk shed is found within the city of Mekelle [245].

In the Mekelle milk shed, the raw milk market largely dominates. Only 5-8 supermarkets are operating in the city of Mekelle, yet these are not the major outlets for milk. Milk shops on the other hand are numerous in the city and thus represent the main sales outlets for liquid and processed milk. During data collection we found only one active milk processor in the Mekelle milk shed which has faced many difficulties in starting up, and still operates below capacity (Figure 2-10)⁸. This milk area is frequently plagued by feed problems both in terms of quantity and quality, due to drought, limited availability of industrial by-products, and limited use of improved forages. In contrast to the Great Addis milk shed, where rainfall is bimodal (most precipitation falls in June-early September and short rain showers in March-mid May), the Mekelle milk shed is confronted with an extended dry period of nine to ten months [245].



Figure 2-10: From left to right: Mekelle milk processing plant, storage of processing plant, pasteurized milk package sold, advertisement of the pasteurized milk

⁸ During a discussion I had with the plant manager, he reported that the plant employs 12 people and processes 600-700 litre per day. During fasting periods, capacity is reduced and only 400 litre of liquid milk is processed. Milk is collected from 9 primary cooperatives which are located 40-50 km away from Mekelle city. This plant thus does not source milk from urban dairy producers.

Table 2-6 summarizes some of the main characteristics of the urban milk producers we interviewed during the first data collection round in 2016. As was the case for urban producers in Addis Ababa, we find that most of the urban dairy farms in Mekelle city are small-scale production units, with producing households reporting to own, on average, 3 dairy cows. All farms owned cross-bred cows which (partially) explains the high milk yields reported. Urban producers in Mekelle have specialized in liquid milk sales, and only a small percentage (less than 1%) of the produced milk is processed within the household during non-fasting periods. Urban producers in Mekelle were found to sell mostly to FSPs, although individual consumers remain also here an important buyer of milk in the city.

Table 2-6: Main descriptive statistics of the interviewed milk producing households in the city of Mekelle during own fieldwork

	Unit	Urban producing households
Dairy cows	#	3.2
Farms that have cross-bred cows	%	100
Milk yield	L/day/cow	11.0
Dairy farms selling liquid milk	%	100
<i>Of total liquid milk produced during a non-fasting period:</i>		
Used for own-consumption	%	3.4
Sales of liquid milk	%	94.4
Processed milk	%	0.9
<i>Farms reporting as main buyer:</i>		
Consumer	%	35.4
FSPs	%	54.1
Trader	%	10.5

In Chapter 5, we come back to these producing households, where we make a characterization of the different dairy farm types we sampled in the city of Mekelle. In what follows we will provide more details on milk shops and the urban milk consumers. During informal discussions with the urban milk producing households, we noticed that milk shops are an increasingly important FSP in the city. We therefore interviewed 40 of these milk shops in January-February 2016. We also take a closer look at the different types of milk consumers: those who rely on own production to satisfy their milk needs and others who exclusively rely on milk purchases, we therefore rely on data we collected during a second round in 2017.

3.2.1. *Milk shops are the new black: Gaining insight in modernizing traditional food retail in Ethiopia*

Food systems are rapidly transforming in developing countries due to changing diets and rapid urbanization. Diets get more diversified with a higher inclusion of non-staples, especially processed foods and ASFs, and households become increasingly dependent on purchased produce rather than home-produced food. Both processes have contributed to a significant transformation of food markets in urban areas [1]. Food is mainly marketed through informal channels with 70% of the urban households regularly purchasing food from the informal market [246]. Many small and medium enterprises (SMEs) are operating in these informal markets in wholesale, logistics, processing, and/or retail. Since many of actors involved in the informal food economy operate unregulated, little is known about these actors, and they are often referred to as the hidden middle [247]. Yet, the informal economy is crucial to urban food security for several reasons: i.e. its physical proximity, its lower food prices, its employment generating capacity, and its inclusion of smallholder producers [248]. SMEs have grown and proliferated rapidly in the past years and are expected to play a key role over the next 10-20 years. Yet, these SMEs remain a blind spot within academic literature and policy debates [247].

Literature on retail transitions has largely focused on the rise and expansion of supermarkets [249-251]. The informally⁹ operating SMEs involved in retail, however, have been largely ignored because of the predominant speculation that modern retailers, such as supermarkets, would largely replace these traditional outlets. Yet, empirical evidence shows that this is not the case [253, 254]. Moreover, these traditional retail outlets are modernizing steadily to better fit the changing consumer needs.

Traditional retail outlets have a number of advantages over supermarkets. First, traditional retailers are more convenient than supermarkets for most urban consumers because these outlets are located closer to consumers' houses, they allow to buy smaller quantities of food, at lower prices, and often on credit [248]. Second, traditional outlets create more employment opportunities, offer greater flexibility to respond to business opportunities, and require little investment. They are thus open to people with limited assets and constrained access to finance. Informal trade is especially important for women, who are the primary suppliers of street food and perishable goods, such as milk [255]. Third, whereas supermarkets require large and uniform volumes of food to be supplied by producers, informal channels are better adapted to the African reality of subsistence agriculture and production seasonality. Furthermore, traditional outlets are believed to offer higher margins to producers given their smaller operational costs [248, 256].

⁹ Informal activities are unlicensed or unregulated activities [252].

In Ethiopia, milk and associated products end up in three major market outlets: open markets, milk shops, and supermarkets [257]. Open markets, defined as the sum of direct sales from producers to neighbouring households, as well as door-to-door sales by itinerant milk traders, are the most important market outlet for Ethiopian households. Supermarkets, seen as modern retailers, are still not widespread in Ethiopia. Bekele et al. [257], who interviewed 600 households in Addis Ababa and surrounding peri-urban towns, find that more than 80% of the households never frequent supermarkets. Milk shops, i.e. specialized milk retailers, are the only frequently used alternative to open markets. Milk shops have emerged as a hybrid market outlet in between the traditional open market and the modern supermarkets. They can be considered as modernized traditional actors selling traditionally produced milk. These shops, also termed milk bars or milk kiosks, are increasingly emerging in town and city centres, especially where dairy farming is common. As opposite to open markets, these shops have a physical location and also possess fridges to preserve the milk, while contrary to modern retailers, they do not have cash register machines [257].

Bekele et al. [257] further studied consumer preferences for traditional (i.e. milk shops and open markets) versus modern retailers (i.e. supermarkets), and found that Ethiopian consumers still prefer traditional outlets because of their lower prices, the local variety offered, the perceived better quality of milk products (especially in terms of freshness and flavour) and the proximity of these outlets since these outlets are numerous and scattered over towns and cities. Another advantage of these traditional retailers is that they allow to purchase milk products in variable quantities, which is important given the low coverage of fridge ownership forcing households to make frequent purchases of small quantities of milk [16]. Ethiopian consumers still prefer traditional milk products over the industrially processed milk (e.g. pasteurized milk and butter, milk with reduced fat content, and milk powder) typically offered by supermarkets. Pricing seem to minimally affect consumer preferences and resource-rich households still prefer traditional outlets over supermarkets [258]. Similar findings were reported by Francesconi et al. [16]. And although there is a growing consumer awareness on food safety hazards and food quality concerns, trust in traditional retailers keep attracting consumers to these outlets [259].

Yet, to the best of our knowledge, no study has characterized milk shops so far. Therefore, we undertook an explorative study to describe shop ownership, management and retail activities. During the data collection in January-February 2016, we conducted structured interviews with 40 milk shops in Mekelle. The questionnaire can be found in Appendix 1. Milk shops are spread over the seven sub-cities of Mekelle, yet, we found a significantly larger concentration in two sub-cities: Kedamay Weyane, the most central sub-city, and Adi Haqi, a sub-city known for its dairy production activities. Most milk shops interviewed were located in these two sub-cities (Figure 6-1). The pictures in Figure 6-2 give a glance on the traditional features of how the milk shops are organized and advertised.

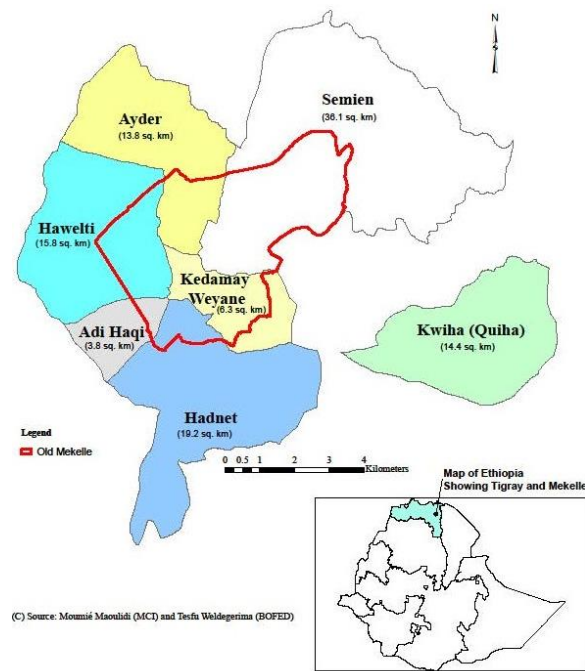


Figure 2-11: Map of Mekelle city with it seven sub-cities



Figure 2-12: From left to right: entrance of two different milk shops; banner advertising a nearby milk shop; banner with list of milk shop products; butter sold at shop and preserved in fridge

Shop owners

Having a closer look at milk shop owners (Table 6-1), we find that all the shops interviewed were privately owned and the majority had only one owner (34 out of 40). Single owners were mostly female and not married (either single or divorced). Owners are relatively young with more than half of the shop owners being under 30 years old. Owners mostly enjoyed either secondary or higher education. Vocational training was also not exceptional. All shop owners indicated to affiliate to the Orthodox Christian religion.

Table 2-7: Descriptive characteristics of the milk shop owners

Number of owners				
		Single ownership (n=34)	Shared ownership (n=6)	
			Head	Spouse
Sex	Female	26	0	6
	Male	8	6	0
Age	20-29	21	0	2
	30-39	9	2	4
	40-49	2	4	0
	50-59	2	0	0
Marital status	Single	21	0	0
	Married	6	6	6
	Divorced/separated	7	0	0
Educational attainment	No education	2	3	2
	Vocational training	11	0	0
	Primary education	3	2	2
	Secondary education	13	0	2
	Higher education	5	1	0
Religious affiliation	Orthodox	34	6	6

Shop management and retail activities

Table 6-2 summarizes some descriptive characteristics of the interviewed milk shops. Shops were opened relatively recently, and no shop existed longer than 3 years. More than half of the shops employs 1 or 2 workers on a daily basis. These workers are exclusively women, and we found only one shop that hired a male worker next to a female worker. None of the shops is currently member of a cooperative or association, and 3 shops indicated to have been a member in the past. The most important reasons mentioned not to join an association are the lack of an association nearby, lack of trust, and negative word-of-mouth. Half of the shops took credit, mostly from a microfinance institution and three-quarters had already repaid the loan. Owners seem to be embedded within a network of fellow shop owners as more than two-thirds of the shops indicate to know at least 1 other milk shop owner personally. Furthermore,

13 of the interviewed shop owners indicated that they have (a) relative(s) also owning a milk shop.

Milk shops source their milk exclusively from milk producers with whom they have predominantly unwritten agreements. Milk quality seems to be the most important specification in this agreement, which is of utmost importance to maintain their store reputation. Milk quality is usually determined using a lactometer. Milk is bought daily from milk producers. Most shops seem to establish personalized linkages with their milk providers, suggested by the fact that two-thirds of the shops use upfront or delayed payment, which can only be established if there is sufficient interpersonal trust (Table 6-2).

During non-fasting periods, shops purchase about 60 L of milk daily with milk producer prices fluctuating around 13 ETB per litre (Table 6-3). During Orthodox fasting, shops buy only half of this volume and producers are paid about 3.5 ETB less. Both during fasting and non-fasting half of the purchased milk is converted to milk products, mostly yoghurt and butter. Only two of the shops we interviewed processed milk to cheese¹⁰. Milk sales are barely affected by fasting and daily sales reach about 20 L of liquid milk, 1.5 kg of butter and 8-10 L of yoghurt. Yet, it seems that a bias has occurred in data reporting by the shop owners. When detailing the difference between quantity of milk purchased on the one hand and quantity of purchased milk being processed and/or sold on the other hand, we found that this difference was equal to zero for only 21 out of the 40 shops. For the other shops, there was a tendency to report higher milk sales and processing volumes compared to the amount of milk purchased from farmers during fasting periods (the difference was 7.23 L on average), while the opposite holds during non-fasting periods (e.g. part of the milk purchased seems not to be sold nor processed, with the difference being 8.13 L on average). This might thus explain the strange patterns popping up in Table 6-3, i.e. reduced purchase of milk, while milk sales are not affected by fasting periods. For the 21 shops that did not under- or overestimate the milk being sold and processed, it appears that supply is cut by 62% during fasting, and milk sales go down with 58%, while the amount of milk being processed is reduced by 67%.

Prices charged for liquid milk in the shop are 1-2 ETB higher than the prices paid to milk farmers. Shop owning interviewees mention that prices of liquid milk and yoghurt drop with 3 ETB during fasting, while butter prices are 13 ETB lower during Orthodox fasting. Yoghurt prices are twice the price of liquid milk while butter prices are 13 times the price of liquid milk. The yoghurt is made by letting raw milk ferment naturally for about 2-4 days in traditional utensils [260]. Part of the fermented milk is used to process it further to butter or cheese.

¹⁰ Since we have only 2 observation for cheese production, sales and prices, we do not elaborate on these numbers in the text.

Shops' clientele is not very large. 7 shops indicate to have less than 10 customers. Half of the shops has 10-29 customers. This highlights that milk shops are still quite niche outlets in the dairy value chain. Only 5 shops claim to have more than 40 customers, with a reported maximum of 100 customers. 42.5% of the shops knows more than 10 of these customers personally, while only 5 of the interviewed shops recognized that they do not know any customer personally.

Table 2-8: Descriptive characteristics of the interviewed milk shops

		Percentage of shops (n=40)
General characteristics		
Ownership	Single	85
	Shared	15
Shop existence	<1 year	22.5
	1 year	32.5
	2 years	30
	3 years	15
Use of hired workers (yes)		62.5
Member of cooperative/association/group		0
Credit uptake (yes)		50
Number of relatives having a milk shop	0	67.5
	1-2	22.5
	>2	10
Number of fellow milk shop owners known personally	0	27.5
	1-4	47.5
	5-10	25
Milk sourcing arrangements		
Terms of agreement	Written	7.5
	Unwritten	92.5
Agreement specifications	Quantity supplied	40
	Price	37.5
	Milk quality	95
Payment arrangement	Upfront	2.5
	Daily	35
	Delayed	62.5
Number of milk farmers known personally	0	2.5
	1-2	30
	3-4	35
	>5	32.5
Retail activities		
Sold milk products	Liquid milk	100
	Yoghurt	100
	Butter	80
	Cheese	5
Number of customers	<10	17.5
	10-19	25
	20-29	30
	30-39	15
	>40	12.5
Number of customers known personally	0	12.5
	1-4	32.5
	5-9	10
	>10	42.5

Table 2-9: Descriptive statistics on milk procurement, processing and sales during Orthodox fasting and outside long fasting periods (n=40; recall by all shop owners)

	Mean (Standard error)	
	Fasting	Non-fasting
Milk sourced (L/day)	23.98 (2.91)	59.25 (5.12)
Producer milk price (ETB/L)	9.88 (0.26)	13.23 (0.17)
Milk processed (L/day)	12.55 (1.57)	29.55 (3.01)
Sales quantities		
Liquid milk (L/day)	18.65 (2.80)	21.58 (2.87)
Butter (kg/day)	1.34 (0.31)	1.66 (0.47)
Yoghurt (L/day)	8.28 (1.24)	10.01 (1.49)
Cheese (kg/day)	0.53 (0.35)	0.28 (0.25)
Sales prices		
Liquid milk (ETB/L)	11.62 (0.35)	14.68 (0.29)
Butter (ETB/kg)	176.36 (10.32)	189.46 (12.18)
Yoghurt (ETB/L)	24.89 (8.03)	27.97 (8.39)
Cheese (ETB/kg)	110 (70)	120 (80)

Note: 1 USD= 23 ETB at the time of the survey

Conclusion

Milk shops, small sales point for liquid and processed milk, are increasingly present in urban areas. Most milk shops were recently established. These shops procure raw milk daily from milk producers. Half of this milk is sold, after boiling and cooling, and the other half is processed, mostly to yoghurt and butter using local processing techniques.

Milk shops provide an alternative market that establishes a short supply chain between producers and consumers. Moreover, these shops offer a lot of potential for value addition. Interestingly, these milk shops, although they cut their milk supply by half during fasting, still operate during long fasting periods. This is surprising, especially in the context of Mekelle, where over 95% of the population is Orthodox Christian, and by default is obliged to fast during several long fasting spells. Yet, reducing their prices during fasting allows them to maintain their milk sales. Important to nuance here is that we found evidence that a large group of shop owners we interviewed overreport their milk sales during fasting, and for those who did not, we find that milk sales are cut by 58% during fasting periods.

Another interesting result is that we find that milk shops are gender inclusive and more than half of the shops were owned solely by women. Furthermore, these shops offer employment mainly to other women. Shop owners are relatively young and well-educated.

3.2.2. Urban milk consumers: Do they look alike?

Next in this section, we take a closer look at urban milk consumers. Some of these consumers source milk from own production, while others exclusively rely on the market to purchase their milk. Producing households have better access to milk, which might affect their milk intake volumes relative to those households who exclusively rely on the market for sourcing milk. Furthermore, households engaged in dairy production might have different socio-demographic profiles. During the data collection of August-September 2017 in Mekelle, we interviewed 250 households that are exclusively purchasing milk and 250 milk producing households. In the survey we collected descriptive data for the household head, the household at large and the household's milk intake and milk sourcing strategies in the week prior to the interview. This enables us to compare both households on a number of key household characteristics (Table 6-4)¹¹.

We find that heads of milk producing households are, on average, significantly older and less educated than heads of milk purchasing households. Milk producing households have a rather traditional family structure, i.e. with head, partner and children, while a significantly larger proportion of heads in milk purchasing households is single. Milk producing households are larger (on average 1.5 extra household members) and children are more represented in these households than in milk purchasing households. High prices for milk probably make it interesting for households to keep their own milking cows especially when they have many children, who are commonly prioritized for milk intake in households throughout the country [7]. Household incomes do not differ significantly between both types of households, but more milk producing households report to earn income in kind.

Regarding consumption of liquid milk, we find, as expected and also described in World Bank [261], that a higher proportion of milk producing households indicated to have consumed milk in the week prior to the interview. Likewise, the total milk intake volume as well as the intake volume per member (accounting for different household sizes) is significantly higher for milk producing households given their direct availability of milk. This indicates that cow ownership is still key in Ethiopia to satisfy household's milk needs, even in urban areas which have rather well-developed local markets for milk. This to some extent contradicts the findings of Hoddinott et al. [27] who argue that market development can substitute for household cow ownership. High milk prices, in part driven by increasing production costs and milk shortage (especially in urban areas), still limit the affordability of milk and associated products, especially for those that exclusively rely on milk purchases.

¹¹ Two sample t-tests (continuous variables) and chi-square tests (categorical) were used to detect significant differences on key variables between both groups.

Table 2-10: Demographic characteristics and milk intake pattern among milk producing and milk purchasing households in the city of Mekelle

	Milk producing households (n=253)	Milk purchasing households (n=251)
Demographics – HH head		
Proportion female	0.20 ^a	0.24 ^a
Age (years)	47.55 (0.83) ^a	43.23 (0.80) ^b
Educational background (proportion)		
No schooling	0.19 ^a	0.06 ^b
Religious education	0.05 ^a	0.03 ^a
Junior primary	0.19 ^a	0.08 ^b
Senior primary	0.30 ^a	0.27 ^a
General secondary	0.08 ^b	0.15 ^a
Preparatory secondary	0.06 ^a	0.08 ^a
Higher education	0.12 ^b	0.32 ^a
Marital status (proportion)		
Single	0.04 ^b	0.11 ^a
Married	0.83 ^a	0.74 ^b
Divorced/separated	0.07 ^a	0.06 ^a
Widowed	0.05 ^a	0.08 ^a
Proportion working for income	0.96 ^a	0.91 ^b
Demographics – HH		
HH size (number)	6.16 (0.14) ^a	4.71 (0.13) ^b
Share of children on total HH size	0.69 (0.05) ^a	0.56 (0.03) ^b
Dependency ratio	0.34 (0.11) ^b	0.40 (0.14) ^a
Total monthly income (ETB/HH member)	2,740.03 (178.79) ^a	2,977.33 (344.72) ^a
Proportion earning in-kind income	0.19 ^a	0.06 ^b
HH milk consumption		
Proportion that consumed liquid milk in the week prior to the interview	0.85 ^a	0.63 ^b
Liquid milk consumption per HH member past week conditional on HH consuming milk (L/member)	1.21 (0.08) ^a	0.92 (0.07) ^b

Note: ^{a-b} Means or proportions with different superscripts differ significantly ($p < .05$). Where applicable, standard errors are given in parentheses.

CHAPTER 3

Religion, food choices, and demand seasonality: Evidence from the Ethiopian milk market

This chapter is based on:

D'Haene, E., Desiere, S., D'Haese, M., Verbeke, W., and Schoors, K. (2019). Religion, food choices, and demand seasonality: Evidence from the Ethiopian milk market. *Foods*, 8 (5): 167. DOI: 10.3390/foods8050167

Abstract

The impact of religious behaviour on food systems in developing economies has been understated in scholarly studies. With its different Christian, Islamic, and traditional faiths, Ethiopia emerges as a natural experiment to investigate the impact of religious practices on demand. The inclusion of animal-sourced foods in Ethiopian diets is extremely low, even by African standards; a phenomenon often explained by supply and marketing problems combined with low-income levels. We deviate from this dominant narrative and single out the impact of religion. We show how fasting practices of Orthodox Christians, the largest religious group, affect milk intake decisions. Employing country wide data collected by the Living Standards Measurement Studies, we find, as expected, that Orthodox fasting adversely affects milk consumption in Orthodox households, an effect we quantify in this chapter. Moreover, we observe spill-over effects of Orthodox fasting on other religious groups in dominantly Orthodox localities. Our findings improve the understanding of the broader societal implication of religiously inspired consumption rituals and underscore the challenges resulting from religion-induced demand cycles to design policies that aim at developing the livestock sector.

Keywords: Orthodox Christian, demand seasonality, fasting, Ethiopia, milk acquisition, milk intake, national

1. Introduction

The term 'Livestock Revolution' was introduced by Delgado et al. [262] to point to the unprecedentedly rapid increase in demand for livestock produce noted in the developing world since the 1970s. Population growth, progressive urbanization and growing per capita income levels are thought to be the revolution's driving forces [262]. While individual intake of ASFs indeed exploded in some transforming and urbanised economies of Asia and Latin-America (particularly in China, India, and Brazil), the livestock revolution surpassed the majority of developing countries. Annual growth rates of per capita milk, meat and egg consumption in SSA were -0.2%, 0.2%, and 0.3% respectively for the period 1987-2007 [3]. Problems of structural supply, poorly developed local markets, low-income levels, and lack of consumer awareness regarding the nutritional benefits of ASFs have been advanced to explain this stagnation. Yet, the association of low intake of ASFs with cultural values and practices in general, and religion in particular, has been largely neglected and understudied; a research gap we address in this chapter.

The significance of including an appropriate level of ASFs in diets to improve dietary quality and nutritional outcomes is underpinned in an abundant number of studies, see for example Muslimatun and Wiradnyani [263] and Zhang et al. [264]. ASFs are valuable and dense sources of several micro and macronutrients which are hard to retrieve in adequate amount from plant source foods only [38]. Livestock-based interventions are therefore deemed to be a decisive strategy to reduce malnutrition, especially in SSA where half of the world's malnourished population is residing, and where diets predominantly consist of cereal or root staple crops [40]. Of all livestock produce, milk is the largest source of animal-based protein in developing countries. It accounts for 60% of total per capita consumption of primary ASFs (i.e. meat, milk, and eggs) [3]. Particularly the fact that milk production has one of the lowest production costs when compared to other plant and animal protein sources, makes it a desirable source of nutrients for improved nutritional and health outcomes in developing countries [39].

Within SSA, Ethiopia hosts the largest estimated livestock herd [36], yet Ethiopian diets contain relatively little ASFs. Animal produce account for only 1.7% and 3% of the total energy intake of rural and urban households respectively [238], whereas starchy staples provide three-quarters of the total calorie intake [237]. Desiere et al. [265] reported that only 19% of the households interviewed by the LSMS programme in Ethiopia consumed meat or fish. In August 2015, the Ethiopian government launched the national Livestock Master Plan to boost livestock production and productivity. Roadmaps were developed for different key livestock value chains. Although the plan acknowledges the importance of promoting livestock produce consumption, the core of the proposed interventions relates to improving livestock production and productivity through enhanced herd management,

genetic resources, feed, and health care [266]. With this one-sided policy focus on supply side factors, the gap between demand and supply of ASFs is likely to widen further in the future.

By contrast, our study emphasises the importance of the demand side of the milk market. Changes in ASF consumption patterns in SSA societies not only depend on changing income levels, but also reflect prolonged cultural processes that are influenced by deeply embedded religious traditions. Robinson and Pozzi [267] point out that particularly cultural and religious values and practices have slowed down the substitution of high value foods such as ASFs for starchy staples in African food baskets. So far, consumption-oriented research has mostly ignored or underestimated the role of the diverse cultural and religious traditions in everyday life decisions [5].

In terms of faiths, Christianity (63%) and Islam (30%) are the two dominant religious affiliations in SSA [224]. Both religions have been co-existing for centuries and are among the fastest growing religious faiths in SSA [268]. Ethiopia, the second most populous country of the continent, is home to Orthodox (44% of the population), Muslim (34%), Protestant (19%), Catholic (1%), and traditional faiths (3%) [15]. The country hosts the second largest community of Orthodox Christians in the world after Russia [269]. The particular fasting rituals are one of the main identifying factors of the Orthodox Church. During fasting spells, which are scattered throughout a religious year, Orthodox followers are presumed to pursue a vegan diet, hence to abstain from consuming any ASF. With around half of the Ethiopian population being member of the Ethiopian Orthodox Church and a total sum of about 166-250 Orthodox fasting days per year [8, 16, 17], religion inevitably influences demand for animal produce in the country. Although several studies mention that fasting undeniably impacts livestock consumption patterns as it is causing a seasonal demand cycle [8, 17], none has attempted to quantify the effect of fasting practices on livestock consumption decisions of households at a national level.

This chapter aims at evaluating the impact of religion on household's milk intake decisions and milk sourcing strategies in Ethiopia. This chapter aims at evaluating the impact of religion on household's milk intake decisions and milk sourcing strategies in Ethiopia. Using country wide data collected by the Living Standards Measurement Studies (LSMS), we address the following three research questions: (1) do Orthodox households limit their milk consumption during fasting and will they limit their milk consumption more when surrounded by an increasing density of Orthodox Christians?; (2) do non-Orthodox households limit their milk consumption during fasting?; and (3) does fasting limit market development and thus consumption outside fasting periods? While the data collected in the LSMS programme are not intended to study the effect of Orthodox fasting seasons on food intake and food market development, we could use this dataset because of the partial overlap of the data collection (February-April 2014) with the longest continuous fasting period of the Orthodox community, i.e. Lent, a 55-day fast preceding Easter. This timing allows us to compare milk intake decisions and milk acquisition strategies outside and during Orthodox fasting periods among the

different religious groups in the country: Orthodox Christians, Protestants, Muslims, and others (i.e. Catholics and traditional faiths).

Our results show important impacts of fasting. First, Lent fast reduces the likelihood of Orthodox households to consume milk by one-third as compared to the period outside Lent fast, *ceteris paribus*. Lent fast especially impacts Orthodox households who have no young children (aged 0-6 years), and these households see their probability to consume milk reduced by two-thirds during the Lent fast. An increasing concentration of Orthodox Christians reduces the likelihood of Orthodox households to consume milk both during and outside the Lent fast period, but Lent fast does not decrease their likelihood to consume milk more as compared to outside the Lent fast period when they are increasingly surrounded by Orthodox members. This seems to suggest that there is no difference in the strictness with which Orthodox households adhere to fasting practices between Orthodox minority or Orthodox majority settings, at least not for the Lent fast period.

Second, fasting rituals not only affect the practicing Orthodox group, but spill over to other religious communities, and in particular to the Ethiopian Muslim community. Such an impact was not found among Protestant households – we rather observe an opposite trend – which seems to suggest that fasting norms mainly spill over to the Muslim community.

Third, we find evidence that increasing densities of Orthodox Christians significantly reduce the probability of households to consume milk, irrespective of the religious affiliation of households. As such we find that a 1% increase in Orthodox concentration reduces the probability of a household to consume milk by 10 percentage points, *ceteris paribus*. We find that if households consume milk in dominantly Orthodox settings, they are significantly less likely to source this milk from the market. These observations point to hampered local market development and reduced milk availability in dominantly Orthodox settings which impact milk consumption among Orthodox and non-Orthodox households even outside fasting periods.

Based on these findings, we argue that religious values and practices – along with other factors – lie at the root of the observed low and stationary consumer demand for animal produce in the country and contribute to an intentional demand seasonality. Further research is needed to address the limitations of the dataset we use (cross-sectional and recall data) and to assess more in detail the impact of fasting on the supply chain and milk market, which we address later on in this dissertation (Chapter 4 and 5).

Our research contributes to the literature on economic and societal impact of religion in food systems in four important ways: (1) we study fasting among Orthodox Christian households and its impact on milk consumption in an African context, while most research was done on religion and food habits and consumer choices in a Western context within the predominant studied religion of Islam; (2) we present results from a nationwide study, while other studies are limited to case studies of a few

villages or cities; (3) Ethiopia hosts households of different religious affiliations, which allows the setting of a natural experiment to investigate the impact of religious practices; and (4) the study shows the broader societal impact of Orthodox fasting which is due to important spill-over effects on consumption and sourcing patterns of households across religious affiliations. This should draw attention of policy makers when designing livestock programmes.

2. Background

2.1. Linking religion and consumer behaviour

Research has tried to link habits, norms and/or customs to various outcomes at household, regional, sectorial, national and international levels. Cultural factors have been linked to (among other): marriage patterns [50], educational attainment [51, 52], migration intention [53], sanitation practices [54], fertility rates [55], female labour force participation [56], wages differentials [270], aid allocation [57], service supply [58], resource management [59], technological innovation [271], state governance [272], corruption [60, 273], happiness [61], economic growth [48, 62], poverty [274], and agricultural productivity [63, 64]. How culture in general, and religion in particular, influences consumption behaviour, however, is vastly understudied. Religion influences consumers both directly via explicit instructions laid out in holy texts and/or by religious leaders and indirectly through beliefs and attitudes established within the larger religious group [275]. Quantitative analyses on the impact of specific religious beliefs and practices on consumer behaviour and associated market outcomes remain scarce and scattered [5, 77].

A large majority of the studies to date unravel behavioural intentions rather than revealed behavioural actions and have a predominant focus on Islamic traditions. Furthermore, the available empirical research is mostly business oriented. These studies are informative for advertising strategies, store and brand image building, product decisions, and establishing (new) market channels. Fam et al. [276] and Putrevu and Swimberghek [277] find that offensiveness vis-à-vis advertising controversial product groups (like gender related produce) differs significantly across religious groups and levels of religiosity. Some studies give valuable insights that can guide the establishment of particular religiously guided market channels e.g. Verbeke et al. [85] and Heiman et al. [5] who focus on different halal and kosher certification systems and accompanying supply channels.

Consumption behaviour for products that are linked to religious practices is also mirrored by demand differences towards specific product characteristics, e.g. environmentally friendly produce [278], fairtrade products [279], genetically modified products [280], and whole fresh chicken versus cut or frozen chicken [105]. While the diverse range of topics reflected in the literature shows the desire of researchers to gain insight into traditional values and religious patterns from the point of view of marketing and consumer communication, it also shows that the broad impact of religion in shaping individual and collective food consumption choices has been understated in scholarly studies [5]. Rather than focusing on the narrow perspective of religious food specifications, we intend to improve our understanding of religiously inspired consumption rituals and their broader societal implications.

2.2. Costly religious food restrictions

Rules and restrictions are inherent to religious institutions and often relate to dietary practices. These food restrictions give rise to distinct consumption patterns and are established either temporarily (such as fasting) and/or permanently (e.g. restriction to kosher and halal food in Jewish and Islamic traditions respectively) and require either abstinence from all (e.g. Ramadan from dawn to sunset) or certain foods (e.g. by the abstinence from ASFs for Orthodox Christians) [281].

Fasting is a fundamental pillar of several religious groups. Various studies analyse how participation in Ramadan, the Islamic fasting month, affects outcomes, such as dietary and nutrient intake [127, 282], mental and physical health [283, 284], educational performance [141, 285], physical performance [286, 287], foetal development [285, 288], and output growth [289].

The existing literature on Orthodox Christians mainly concentrates on the Greek community and examines how religious fasting impacts physical and biochemical body parameters through changing food and nutrient intake patterns [190, 290, 291]. Only one previous study directly addresses the fasting practice of the Orthodox Church in Ethiopia. Knutsson and Selinus [78] elaborate on the longest Orthodox fasting period preceding Easter, known as Lent, and how it impacts food intake among households and factory workers in the capital, Addis Ababa, and one village in the Oromia region. They detect a substantial drop in the total volume and quality of protein intake by small children between the age of six months and three years, which can be attributed to the exclusion of milk and other ASFs from their diet during Lent fasting. Given the modest appearance of animal produce in non-fasting periods, fasting resulted in a deficiency of 25% compared to recommended total protein intake, which might be harmful for children's growth and development.

Other authors indirectly controlled for Orthodox fasting practices in their papers. Hirvonen et al. [238] who studied seasonality trends in Ethiopian diets, uncovered that the average energy intake and diversity of urban households' diets sharply fell during the two main Orthodox fasting periods (Lent and Advent). This trend was not observed in rural areas, possibly because ASFs are not as regularly incorporated in rural diets. Other studies mention how Orthodox fasting practices affect ASF purchases, availability, and sales. Negassa [6] evaluates the determinants of purchasing raw milk and butter within two towns of the Oromia region, accommodating 200 urban households. They observe that households who participated in fasting were less likely to purchase raw milk and butter. Moreover conditional on household's purchases, the quantity of raw milk purchased declined significantly for households practicing fasting, although the effect of fasting on the quantity of purchased butter was not significant, probably because of the small purchase volumes of butter. Ayenew et al. [292], who studied the supply side of the milk market in (peri-)urban areas, found that milk sales and prices were significantly higher during non-fasting days, while there was no such effect of fasting versus non-fasting on the volume of butter sales. Only butter prices were slightly

higher in non-fasting periods. Both observations imply that the reduced milk sales are not compensated for by an increased sale of butter nor is the reduced milk intake during fasting events offset by a rising butter consumption. An older study by Avery [202] on the meat value chain in Addis Ababa reveals that 85% of the butcheries close on traditional Wednesday and Friday Orthodox fasting days and 43% of the supermarkets report a drop in meat sales on those days. Moreover, the France Vétérinaire Internationale-Institute de l'Elevage [293] found that Orthodox fasting practices put great pressure on abattoirs' capacity in Addis Ababa as the number of cattle, sheep, and goats slaughtered fell by 75% during the Orthodox Lent fasting period. Such drop was not observed during Muslim major fasting season (Ramadan). Finally, Aklilu et al. [294] who examined village poultry consumption and marketing in the Tigray region, established that religious fasts and feasts periodically shift local demand, sales, and prices of poultry.

In sum, the above-mentioned literature agrees that fasting rituals in Ethiopia have an undeniable impact on demand seasonality in milk and meat markets which has a costly impact on the livestock sector. This chapter builds on these findings by providing a nationwide quantification of the impact of Orthodox fasting and by estimating the spill-over effects across religious groups.

2.3. The Ethiopian Orthodox Church and fasting practices

Fasting is a ritual commonly practiced within the Orthodox Church. It is seen as an integral part of religious identity, and serves as a measure of piety [78]. As Boylston [295] witnesses, Ethiopian people would rather ask a person first whether he/she would fast instead of asking this person whether he/she is Christian. Unique to Ethiopian Orthodox Church (and broad Orthodox Christian Church by extension) is that fasting is performed during different periods throughout a religious year. Orthodox traditions prescribe their members not to eat any food from animal origin. The fasts performed differ in duration and can be categorised into two main types: one day fasts occurring on Wednesdays and Fridays all year round (except for the two months after Ethiopian Easter) and longer fasting seasons around or preceding holy events. Lent is the longest continuous and most important of all fasts (55 days). Other major fasting periods occur in December-January (40 days) and August (16 days). Besides commonly imposed fasts, a large variety of spontaneous individual fasts is applied which makes it very difficult to assess the exact number of fasting days. Estimates published on the number of fasting days each year in the country vary between 166-250 days [8, 16, 17]. Although fasting rules are strict, pregnant and lactating women, severely ill or weak persons, as well as children below the age of seven can be fully exempt from fasting [292].

3. Materials and methods

3.1. Data

We use data from the LSMS programme, a household survey programme housed within the Survey Unit of the World Bank's Development Data Group that provides technical assistance to the Central Statistical Agency of Ethiopia for conducting the actual survey on the territory of Ethiopia. The empirical analysis is based on data collected from a total of 5262 households in 2013-2014, the second data collection wave. We did not consider the first (2011-2012) or the third (2015-2016) wave as the first wave did not include all urban areas (only rural and small-town areas were surveyed), while the third wave had only 599 observations during Lent across all religious groups, whereas these amount to 1771 in 2013-2014. The data set covers all regional states including the capital, Addis Ababa. Respondents are selected by means of a stratified two stage cluster sample design [296]. A minimum number of enumeration areas (EAs) is set per regional state, using the Probability Proportional to Size sampling method. The EAs correspond to (parts of) municipalities or kebeles, the smallest administrative entities in Ethiopia. In total, 433 EAs are covered by the survey, 290 in rural areas, 43 in small town areas and 100 in major town areas. Within each EA, households are randomly selected.

The LSMS questionnaire provides information on the individual attributes of the household members, including religious affiliation, and household consumption of selected food items using a the seven-day recall period. Respondents were asked whether the household consumed milk in the week prior to the interview. If a household consumed milk in that week, it was asked how much of the consumed milk was sourced from own production and how much was purchased on the market. Only detailed consumption data were available for liquid milk but not for butter. The interviews were implemented between February-April 2014, which was before, during and after Lent (24 February 2014-19 April 2014), the longest continuous fast of the Ethiopian Orthodox Church. As we do not have information about household's actual involvement in fasting rituals, we matched dates of the fasting period with the individual recall period: a household record is labelled fasting if at least part of the seven-day recall period coincides with Lent fasting days, and non-fasting otherwise. This is a reasonable assumption since 87% of the Ethiopian Orthodox Christians report that they fast during holy times such as Lent [32]. We find that a third of the consumption survey records occur during the Orthodox Lent fasting season. This allows us to compare consumption patterns outside and during the fasting season. Ramadan took place later that year outside the data collection period (28 June 2014-28 July 2014). No data were available on the production and/or processing of milk within that seven-day recall period, hence we could only approximate what happens at the local milk market level by looking into milk sourcing strategies by milk consuming households.

3.2. Methodological approach

We start from the premise that religious affiliation – and thus fasting – only influences the decision of a household whether or not to consume milk. We have no reason to expect that, *ceteris paribus*, religious affiliation or fasting as such would influence the level of consumption, conditional on the household consuming milk.

To test which household characteristics are associated with a household's likelihood to consume milk, we apply a Probit regression to model the binary outcome of a household's decision to consume or not to consume milk:

$$Y_{i,z} = 0 \text{ if } Y_{i,z}^* \leq 0 \quad \text{eq. 1}$$

$$Y_{i,z} = 1 \text{ if } Y_{i,z}^* > 0 \quad \text{eq. 2}$$

$$Y_{i,z}^* = \alpha_0 + \alpha_1 F_i + \alpha_2 O_{ea} + \alpha_3 Ch_i + \alpha_4 MC_i + \sum \alpha_i R_i + \sum \alpha_i R_i F_i + \sum \alpha_i R_i O_{ea} + \sum \alpha_i F_i O_{ea} + \sum \alpha_i R_i F_i O_{ea} + \sum \alpha_i F_i Ch_i + \sum \alpha_i R_i F_i Ch_i + \sum \alpha_i F_i MC_i + \sum \alpha_i R_i F_i MC_i + \sum \alpha_i H_i + \sum \alpha_i L_z + \varepsilon_i \quad \text{eq. 3}$$

In the above equations, the dependent variable ($Y_{i,z}$) takes a value one if the household consumed milk during the seven days prior to the survey, zero otherwise. The probability that a household i in locality z chooses alternative one depends on the net utility ($Y_{i,z}^*$) a household derives from consuming milk. Only when the net utility of drinking milk is positive, a household will decide to consume. This net utility, in turn, is shaped by the household's religious affiliation (R_i), whether it is a fasting period (F_i), the density of Orthodox Christians in an enumeration area (O_{ea}), whether or not a household has young children (Ch_i)¹², and whether or not a household has direct access to milk, i.e. whether or not a household owns milking cows (MC_i), a vector of other household (H_i) and location (L_z) controls, and the error terms (ε_i).

Based on empirical studies focusing on determinants of milk consumption, see for example Negassa [6], Njarui et al. [297], Trung et al. [298], and Kusiluka et al. [299], and the available data within the LSMS, we include the following household level controls in our analysis: gender, age, marital status, and educational background of the household head, household's living standard, children between the age of seven and nine, older people (aged 65 and above) and remaining household members. Vulnerable groups such as young children, and elderly people are often prioritized and exempt from religious prescriptions when it comes to milk intake at household level [6, 7] and thus will increase the likelihood of a household to consume milk both during and outside fasting. We also consider dairy goat ownership to further control for the household's direct access to milk. Milk can also be

¹² The dummy variable for young children takes a value one if the household has at least one young child aged between 0-6 years old, zero otherwise.

sourced from sheep and camel. However, none of the households in the sample held dairy sheep and 1.29% of households in the sample had camel, but these were exclusively Muslim households. We thus dropped dairy sheep and camel ownership in the analyses as their contribution in milk intake is negligible. Finally, we add location level controls by incorporating the household's residence (be it in a rural village, a small town or a large town), the milk price to control for market accessibility, and a regional state dummy to adjust for possible variations in milk consumption and production across the regions due to differences in livestock population densities [36] and tribal practices [300]. A detailed description of the dependent and explanatory variables used in the models can be found in Supplementary material A.1, Table S3-1.

More extended statistical analyses to test the robustness of Probit regressions modelling the likelihood of a household to consume milk can be found in the Supplementary material A.2.

Finally, to study the impact of fasting rituals on market development, we extend our analyses and investigate if fasting causes shifts in the probability that a household sources consumed milk from the market¹³. Therefore, we restrict our sample to households who have consumed milk in the week prior to the interview and we study how fasting impacts households' decisions to consume milk from purchase ($W_{i,z}$).

$$W_{i,z} = 0 \text{ if } W_{i,z}^* \leq 0 \quad \text{eq. 4}$$

$$W_{i,z} = 1 \text{ if } W_{i,z}^* > 0 \quad \text{eq. 5}$$

$$W_{i,z}^* = \beta_0 + \beta_1 F_i + \beta_2 O_{ea} + \sum \beta_i R_i + \sum \beta_i R_i F_i + \sum \beta_i R_i O_{ea} + \sum \beta_i F_i O_{ea} + \sum \beta_i R_i F_i O_{ea} + \sum \beta_i H_i + \sum \beta_i L_z \quad \text{eq. 6}$$

In the above equations, the dependent variable $W_{i,z}$ takes a value one if (part of) the milk that a household consumed originated from purchase, and zero otherwise. The probability that a household i in locality z chooses alternative one depends on the net utility a household derives from purchasing the milk it consumes ($W_{i,z}^*$).

¹³ We find in our dataset that households who consume milk either source the consumed milk from own production or from the market, but rarely source it both from own production and from the market.

4. Results

4.1. Descriptive results

To test whether religious affiliation or fasting indeed only affect the decision of a household to consume, we restrict our sample to only consuming households, and we find that average consumption levels per adult equivalent do not differ significantly across religious groups both during and outside fasting periods (Figure 3-1). Fasting thus affects the decision to consume milk, but once a household has decided to consume milk, milk volumes consumed are not affected by fasting seasons.

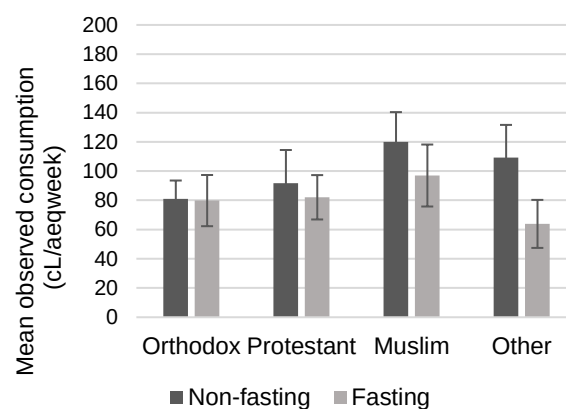


Figure 3-1: Average observed milk consumption for those households indicating to have consumed milk in the week prior to the interview; with confidence intervals drawn at $\alpha=0.05$

When average milk consumption is calculated irrespective of a household's religious affiliation, volumes consumed significantly decrease during Lent: from 1.55 L/household during a non-fasting week recorded in the interviews compared to 1.04 L/household during fasting time. Figure 3-2 gives a comparison of the consumption patterns across the different religious groups (i.e. Orthodox, Protestant, Muslim, and other). Overall, Orthodox households seem to consume less milk compared to other religious communities (Figure 3-2, left part), which can partly be explained by the smaller proportion of Orthodox households that consume milk (Figure 3-2, right part). The left part of Figure 3-2 shows that Orthodox Christians consumed almost 30% less milk during Lent compared to their religious peers outside the fasting season – milk intake drops from 0.66 L/household to 0.48 L/household. This drop might seem small as we would expect consumption to drop to zero, yet, we also still find a large proportion of Orthodox households that consume milk during Lent (Figure 3-2, right part). Comparing the household characteristics of Orthodox households that consumed milk during fasting with those that abstained from milk, reveals that those households that maintain their milk consumption during Lent have significantly larger households with significantly more young children – on average, consuming households had twice as many young children. Moreover, milking

cow herds of these households are twice as large as the herds of Orthodox households refraining from milk intake (Table 3-1).

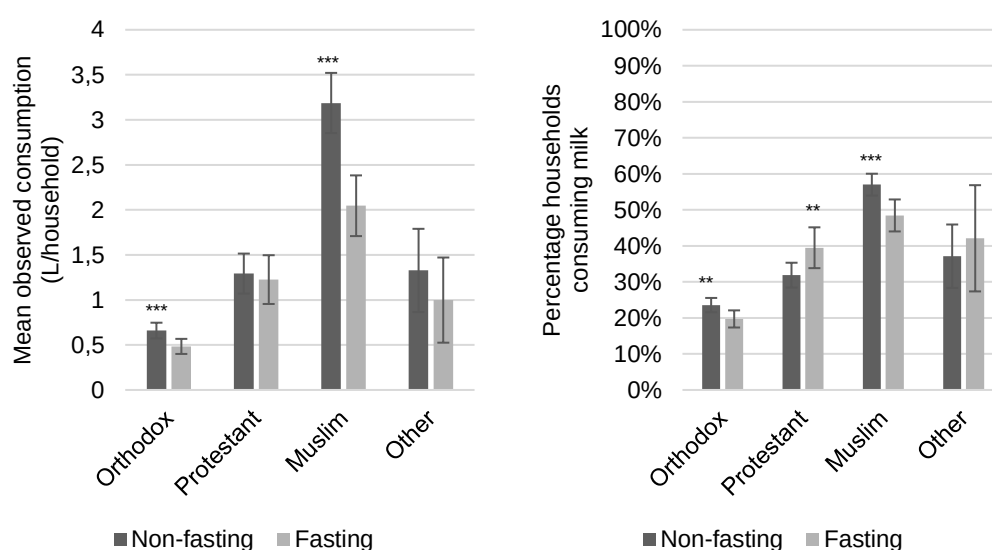


Figure 3-2: Average observed milk consumption (left) and the proportion of households consuming milk (right) across religious groups at Orthodox fasting and non-fasting; with confidence intervals drawn at $\alpha=0.05$

Note: ***, ** and * represent statistical significance at a probability of less than 1%, 5%, and 10% respectively.

Table 3-1: Descriptive household characteristics of liquid milk consuming and non-consuming Orthodox households during Lent

	Mean (SE)	
	Non-consuming Orthodox households	Consuming Orthodox households
Proportion of male heads	0.58 (0.02) ^a	0.64 (0.03) ^a
Age heads (year)	43.17 (0.59) ^a	41.72 (1.01) ^a
Proportion of married heads	0.54 (0.02) ^a	0.70 (0.03) ^b
Proportion of heads with		
Illiterate or informal education	0.40 (0.02) ^a	0.30 (0.03) ^b
Primary education	0.26 (0.02) ^a	0.29 (0.03) ^a
Secondary education	0.23 (0.02) ^a	0.31 (0.03) ^b
College/university education	0.10 (0.01) ^a	0.10 (0.02) ^a
Number of young children (0-6)	0.46 (0.03) ^a	0.86 (0.06) ^b
Number of children (7-9)	0.27 (0.02) ^a	0.35 (0.04) ^a
Number of elderly (65 and above)	0.17 (0.01) ^a	0.12 (0.03) ^a
Number of remaining members	2.93 (0.07) ^a	3.34 (0.13) ^b
Milking cow herd size	0.20 (0.02) ^a	0.44 (0.08) ^b
Milking goat herd size	0.00 (0.00)	0 (0)
Household income (ETB/week)	403.65 (11.92) ^a	683.62 (35.54) ^b
Proportion residing in		
Rural area	0.32 (0.02) ^a	0.26 (0.03) ^a
Small-town area (urban)	0.06 (0.01) ^a	0.04 (0.01) ^a
Large-town area (urban)	0.62 (0.02) ^a	0.70 (0.03) ^b

Note: ^{a-b} Means within a row with different superscripts differ significantly ($p \leq 0.05$).

Moreover, not only Orthodox households seem to reduce their consumption. The difference in milk consumption levels outside and during Lent across Muslim households is notable (left part of Figure 3-2). The right part of Figure 3-2 reveals that the proportion of Muslim households drinking milk reduces from 57% to 49%, which partially explains this sizable drop. An opposite trend is observed among Protestant households. As explained in Section 2.3., consumption, availability, and sales of ASFs alter sharply during fasting. If the milk market unravels during Orthodox fasts, we would expect that milk intake of both Protestant and Muslim households is equally affected by fasting. Yet, this is not what we observe. A tentative explanation for these findings could be that the spill-over of social norms (in this case respecting the Orthodox fasting) is stronger for non-Christian groups, in our case Muslims. Protestants, who belong to the broad class of Christianity, show higher interpersonal similarity with the Orthodox community and thus the social distance between both groups is smaller compared to the distance between Orthodox Christians and Muslims. A vast body of literature on in- and out-group interactions has assessed differential attitude/behaviour/treatment of one group vis-à-vis the other group (which is elaborated more on in Chapter 6 and 7). These studies, however, implicitly consider the out-group to be homogenously composed. We argue that considerable heterogeneity exists within the out-group, especially in terms of social distance and literature has shown that social distance affects judgments and behaviour towards others. Yet, the limitations of our datasets do not allow us to investigate the social norm channel in further detail.

4.2. Modelling results

Results from the Probit regression modelling the likelihood of a household to consume milk as elaborated in Section 3.2 are presented in Table 3-2 (i.e. Probit 1, first column). We gradually build up this model to test the robustness of our significant results. Average marginal effects of the main interest variables in the full Probit model (i.e. Probit 1, first column in Table 3-2) are presented in Table 3-3. Furthermore, predicted probabilities to consume milk at household level at the means of the covariates are shown in Table 3-4 and Table 3-5. As a robustness check, we re-ran the Probit regressions of Table 3-2 but now having continuous variables for both young children and dairy cows. The results can be found in the Supplementary material A.2.

In the discussions below, we focus on the Orthodox, Protestant, and Muslim communities as the group with other religious affiliations was too small (n=143) to draw non-fallacious conclusions.

Fasting clearly impacts household's milk intake as it alters the likelihood of a household to drink milk (Table 3-2). The effects are multiple and not limited to the Orthodox community, and remain fairly constant when gradually building up the model. In what follows, we will focus on the results from the full Probit model, i.e. Probit 1.

First, fasting reduces the likelihood of a household to consume milk by 5 percentage points, *ceteris paribus* (Table 3-3). Although this drop might seem small, part of the household consumption data which are labelled as fasting, reflect consumption both during Lent and non-fasting days, which might happen if a household was interviewed in the beginning of the Lent fasting period or after Lent fasting. When we detail the impact of Orthodox fasting across the different religious groups, we find that the probability of milk intake decreases by 11 and 3 percentage points for Orthodox and Muslim households respectively, while Protestant households' probability increases by 6 percentage points (Table 3-4). Since the Orthodox and Muslim community jointly represent 80% of the Ethiopian population, this observation implies a non-negligible impact of fasting on national milk demand.

Second, when detailing the impact of fasting on households without young children versus households with at least 1 young child, we observe, as expected, that fasting especially impacts households without young children and fasting reduces their likelihood to consume milk by 10 percentage points (Table 3-4). The impact of fasting is the biggest for Orthodox households without young children, who see their likelihood to consume milk cut by two-thirds – from 29 to 11 percentage points, *ceteris paribus* (Table 3-4).

Third, we find evidence that increasing densities of Orthodox Christians significantly reduce the probability to consume milk. A 1 percent increase in the density of Orthodox Christians in an enumeration area reduces the likelihood of a household to consume milk by 10 percentage points, *ceteris paribus* (Table 3-3). When detailing the impact over religious groups and fasting/non-fasting

periods, we observe that an increasing concentration of Orthodox Christians reduces the likelihood of Orthodox households to consume milk both during and outside fasting periods (Table 3-5). Fasting reduces Orthodox households' probability to consume milk slightly more than one-third on average, irrespective of the concentration of Orthodox Christians (Table 3-5). This suggests that there is no difference in the strictness with which Orthodox households adhere to fasting practices between Orthodox minority or Orthodox majority settings, at least not for the Lent fast period. For Protestant and Muslim households, we observe that an increasing density of Orthodox Christians especially reduces their likelihood to consume milk outside the Lent fast period (Table 3-5).

Fourth, we find a large effect of dairy cow ownership. Households who own dairy cows, are 24 percentage points more likely to have consumed milk in the week prior to the interview (Table 3-3). Fasting seems to impact especially those households with dairy cows. These households are 10 percentage points less likely to consume milk during Lent fast, while households without dairy cows are 4 percentage points less likely to consume milk during Lent fast (Table 3-4). Yet, having dairy cows makes households more likely to consume milk even during fasting periods. When detailing the impact of fasting and dairy cow ownership across the different religious groups, we observe that the likelihood of consuming milk by Orthodox households owning dairy cows is almost cut by half during fasting periods, whereas it is only cut by one-third for those Orthodox households without dairy cows. The impact of fasting on other religious groups owning dairy cows is on the other hand neglectable which seems to suggest that dairy cow ownership can help to reduce the impact of Orthodox fasting practices on these households (Table 3-4).

Table 3-2: Results from Probit models modelling the likelihood of a household to have consumed milk in the last seven days prior to the interview

		Probit 1	Probit 2	Probit 3	Probit 4	Probit 5	Probit 6	Probit 7
Religious affiliation (<i>Orthodox Christian omitted</i>)								
	Protestant	-0.23 (0.18)	-0.01 (0.15)	-0.09 (0.16)	-0.17 (0.18)	-0.03 (0.15)	-0.06 (0.14)	0.10 (0.08)
	Muslim	0.28 (0.17)*	0.32 (0.15)**	0.31 (0.15)**	0.28 (0.16)*	0.31 (0.15)**	0.28 (0.14)**	0.34 (0.08)***
	Other	0.67 (0.31)**	0.47 (0.23)**	0.46 (0.25)*	0.68 (0.29)**	0.46 (0.23)**	0.43 (0.21)**	0.39 (0.14)***
Interview period (<i>non-fasting omitted</i>)								
	Fasting	-0.65 (0.23)***	-0.58 (0.23)**	-0.46 (0.23)**	-0.69 (0.23)***	-0.50 (0.23)**	-0.57 (0.16)***	-0.22 (0.05)***
EA Orthodox concentration		-0.38 (0.17)**	-0.38 (0.17)**	-0.38 (0.17)**	-0.38 (0.17)**	-0.38 (0.17)**	-0.41 (0.15)***	-0.38 (0.10)***
Interaction (religious affiliation * interview period) (<i>Orthodox Christian omitted</i>)								
	Protestant * fasting	0.72 (0.32)**	0.36 (0.27)	0.49 (0.29)*	0.68 (0.31)**	0.43 (0.27)	0.53 (0.16)***	-
	Muslim * fasting	0.37 (0.28)	0.17 (0.25)	0.14 (0.25)	0.47 (0.27)*	0.24 (0.25)	0.32 (0.16)**	-
	Other * fasting	-0.29 (0.63)	0.63 (0.43)	0.05 (0.57)	0.21 (0.55)	0.68 (0.43)	0.76 (0.30)**	-
Interaction (religious affiliation * EA Orthodox concentration) (<i>Orthodox Christian omitted</i>)								
	Protestant * EA Orthodox concentration	0.03 (0.30)	-0.08 (0.30)	0.01 (0.30)	-0.03 (0.30)	-0.05 (0.30)	0.03 (0.24)	-
	Muslim * EA Orthodox concentration	-0.20 (0.29)	-0.22 (0.29)	-0.19 (0.29)	-0.22 (0.29)	-0.20 (0.29)	-0.15 (0.23)	-
	Other * EA Orthodox concentration	-1.21 (0.59)**	-1.20 (0.58)**	-1.18 (0.59)**	-1.22 (0.59)**	-1.19 (0.58)**	-1.15 (0.46)**	-
Interaction (interview period * EA Orthodox concentration) (<i>non-fasting omitted</i>)		0.11 (0.27)	0.15 (0.27)	0.21 (0.27)	0.09 (0.27)	0.20 (0.27)	0.28 (0.18)	-
Interaction (religious affiliation * interview period * EA Orthodox concentration) (<i>Orthodox Christian * non-fasting omitted</i>)								
	Protestant * fasting * EA Orthodox concentration	0.20 (0.50)	0.33 (0.48)	0.11 (0.49)	0.30 (0.49)	0.22 (0.48)	-	-
	Muslim * fasting * EA Orthodox concentration	0.28 (0.43)	0.21 (0.43)	0.18 (0.43)	0.22 (0.43)	0.13 (0.42)	-	-
	Other * fasting * EA Orthodox concentration	1.09 (1.05)	0.20 (0.93)	0.91 (1.05)	0.44 (0.96)	0.11 (0.92)	-	-
Young children (<i>no young children omitted</i>)								
	1 or more young children	0.00 (0.08)	0.08 (0.06)	0.18 (0.05)***	0.01 (0.08)	0.19 (0.05)***	0.19 (0.05)***	0.18 (0.05)***
Interaction (interview period * young children) (<i>non-fasting * no young children omitted</i>)								
	Fasting * 1 or more young children	0.63 (0.13)***	0.29 (0.09)***	-	0.59 (0.13)***	-	-	-
Interaction (religious affiliation * interview period * young children) (<i>Orthodox Christian * no young children omitted</i>)								
	Protestant * non-fasting * 1 or more young children	0.26 (0.15)*	-	-	0.27 (0.14)*	-	-	-

Protestant * fasting * 1 or more young children	-0.42 (0.21)**	-	-	-0.40 (0.21)*	-	-	-
Muslim * non-fasting * 1 or more young children	0.10 (0.12)	-	-	0.09 (0.12)	-	-	-
Muslim * fasting * 1 or more young children	-0.62 (0.17)***	-	-	-0.57 (0.17)***	-	-	-
Other * non-fasting * 1 or more young children	-0.29 (0.32)	-	-	-0.29 (0.31)	-	-	-
Other * fasting * 1 or more young children	0.16 (0.53)	-	-	0.26 (0.49)	-	-	-
Dairy cows (<i>no dairy cows omitted</i>)							
1 or more dairy cows	2.41 (0.45)***	2.55 (0.43)***	2.38 (0.45)***	2.54 (0.43)***	2.53 (0.43)***	2.53 (0.43)***	2.53 (0.43)***
Interaction (interview period * dairy cows) (<i>non-fasting * no dairy cows omitted</i>)							
Fasting * 1 or more dairy cows	-0.34 (0.16)**	-0.09 (0.11)	-0.22 (0.16)	-	-	-	-
Protestant * non-fasting * 1 or more dairy cows	0.11 (0.15)	-	0.14 (0.15)	-	-	-	-
Protestant * fasting * 1 or more dairy cows	0.23 (0.25)	-	0.14 (0.24)	-	-	-	-
Muslim * non-fasting * 1 or more dairy cows	-0.08 (0.14)	-	-0.06 (0.14)	-	-	-	-
Muslim * fasting * 1 or more dairy cows	0.49 (0.21)**	-	0.38 (0.21)*	-	-	-	-
Other * non-fasting * 1 or more dairy cows	-0.01 (0.32)	-	-0.02 (0.32)	-	-	-	-
Other * fasting * 1 or more dairy cows	1.53 (0.73)	-	1.53 (0.72)**	-	-	-	-
Household controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Location controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
n	5,074	5,074	5,074	5,074	5,074	5,074	5,074
Log likelihood	-2,361.59	-2,376.14	-2,376.83	-2,367.35	-2,381.50	-2,381.62	-2,392.07
Pseudo R ²	0.27	0.27	0.27	0.27	0.27	0.27	0.26

Note: ***, ** and * represent statistical significance at a probability of less than 1%, 5%, and 10% respectively. Standard errors are given in parentheses.

Table 3-3: Average marginal effects of the main interest variables on the probability to consume milk at household level calculated from the Probit 1 regression in Table 3-2

	dy/dx (SE)
Religious affiliation (<i>Orthodox Christian omitted</i>)	
Protestant	0.04 (0.02)*
Muslim	0.09 (0.03)***
Other	0.07 (0.04)*
Interview period (<i>non-fasting omitted</i>)	
Fasting	-0.05 (0.01)***
EA Orthodox concentration	-0.10 (0.03)***
Young children (<i>no young children omitted</i>)	
1 or more young children	0.05 (0.01)***
Dairy cows (<i>no dairy cows omitted</i>)	
1 or more dairy cows	0.24 (0.03)***

Note: ***, ** and * represent statistical significance at a probability of less than 1%, 5%, and 10% respectively.

Table 3-4: Average predicted probability to consume milk at household level evaluated at the means of the covariates calculated from the Probit 1 regression in Table 3-2

	Average predicted probability to consume milk (SE)
Interaction (religious affiliation * interview period)	
Orthodox Christian* non-fasting	0.29 (0.02)***
Orthodox Christian * fasting	0.18 (0.02)***
Protestant * non-fasting	0.27 (0.03)***
Protestant * fasting	0.33 (0.04)***
Muslim * non-fasting	0.37 (0.04)***
Muslim * fasting	0.34 (0.04)***
Other * non-fasting	0.26 (0.08)***
Other * fasting	0.44 (0.12)***
Interaction (interview period * young children)	
Non-fasting * no young children	0.30 (0.02)***
Fasting * no young children	0.20 (0.02)***
Non-fasting * 1 or more young children	0.32 (0.02)***
Fasting * 1 or more young children	0.32 (0.03)***
Interaction (religious affiliation * interview period * young children)	
Orthodox Christian * non-fasting * no young children	0.29 (0.03)***
Orthodox Christian * fasting * no young children	0.11 (0.02)***
Orthodox Christian * non-fasting * 1 or more young children	0.29 (0.03)***
Orthodox Christian * fasting * 1 or more young children	0.27 (0.04)***
Protestant * non-fasting * no young children	0.23 (0.04)***
Protestant * fasting * no young children	0.29 (0.05)***
Protestant * non-fasting * 1 or more young children	0.32 (0.04)***
Protestant * fasting * 1 or more young children	0.36 (0.06)***
Muslim * non-fasting * no young children	0.35 (0.04)***
Muslim * fasting * no young children	0.34 (0.05)***
Muslim * non-fasting * 1 or more young children	0.39 (0.04)***
Muslim * fasting * 1 or more young children	0.34 (0.05)***
Other * non-fasting * no young children	0.31 (0.11)***
Other * fasting * no young children	0.29 (0.12)**
Other * non-fasting * 1 or more young children	0.22 (0.08)***
Other * fasting * 1 or more young children	0.59 (0.16)***
Interaction (interview period * dairy cows)	
Non-fasting * no dairy cows	0.24 (0.02)***

Fasting * no dairy cows	0.20 (0.02)***
Non-fasting * 1 or more dairy cows	0.57 (0.04)***
Fasting * 1 or more dairy cows	0.47 (0.05)***
Interaction (religious affiliation * interview period * dairy cows)	
Orthodox Christian * non-fasting * no dairy cows	0.22 (0.02)***
Orthodox Christian * fasting * no dairy cows	0.15 (0.02)***
Orthodox Christian * non-fasting * 1 or more dairy cows	0.55 (0.05)***
Orthodox Christian * fasting * 1 or more dairy cows	0.31 (0.05)***
Protestant * non-fasting * no dairy cows	0.20 (0.03)***
Protestant * fasting * no dairy cows	0.26 (0.04)***
Protestant * non-fasting * 1 or more dairy cows	0.56 (0.06)***
Protestant * fasting * 1 or more dairy cows	0.55 (0.09)***
Muslim * non-fasting * no dairy cows	0.30 (0.04)***
Muslim * fasting * no dairy cows	0.26 (0.03)***
Muslim * non-fasting * 1 or more dairy cows	0.61 (0.06)***
Muslim * fasting * 1 or more dairy cows	0.64 (0.07)***
Other * non-fasting * no dairy cows	0.20 (0.08)**
Other * fasting * no dairy cows	0.26 (0.10)***
Other * non-fasting * 1 or more dairy cows	0.51 (0.12)***
Other * fasting * 1 or more dairy cows	0.92 (0.10)***

Note: ***, ** and * represent statistical significance at a probability of less than 1%, 5%, and 10% respectively.

Table 3-5: Average predicted probability to consume milk at household level in areas with 25%, 50%, and 75% Orthodox Christians evaluated at the means of the other covariates calculated from the Probit 1 regression in Table 3-2

		Average predicted probability to consume milk (SE)		
		25% Orthodox Christians	50% Orthodox Christians	75% Orthodox Christians
Religious affiliation				
	Orthodox Christian	0.28 (0.03)***	0.25 (0.02)***	0.22 (0.01)***
	Protestant	0.31 (0.02)***	0.29 (0.03)***	0.27 (0.04)***
	Muslim	0.40 (0.02)***	0.36 (0.03)***	0.32 (0.04)***
	Other	0.43 (0.06)***	0.32 (0.07)***	0.22 (0.08)***
Interview period				
	Non-fasting	0.35 (0.02)***	0.31 (0.02)***	0.27 (0.02)***
	Fasting	0.27 (0.03)***	0.25 (0.02)***	0.24 (0.02)***
Interaction (religious affiliation * interview period)				
	Orthodox Christian * non-fasting	0.32 (0.04)***	0.29 (0.02)***	0.26 (0.02)***
	Orthodox Christian * fasting	0.20 (0.04)***	0.18 (0.02)***	0.17 (0.02)***
	Protestant * non-fasting	0.30 (0.03)***	0.27 (0.03)***	0.25 (0.05)***
	Protestant * fasting	0.33 (0.04)***	0.33 (0.04)***	0.32 (0.06)***
	Muslim * non-fasting	0.42 (0.02)***	0.37 (0.04)***	0.31 (0.06)***
	Muslim * fasting	0.36 (0.03)***	0.34 (0.04)***	0.32 (0.06)***
	Other * non-fasting	0.40 (0.07)***	0.26 (0.08)***	0.15 (0.09)*
	Other * fasting	0.48 (0.11)***	0.44 (0.12)***	0.40 (0.17)**

Note: ***, ** and * represent statistical significance at a probability of less than 1%, 5%, and 10% respectively.

Next, we study how fasting impacts on the milk market development by reviewing the changes in the likelihood to source consumed milk from purchase (Table 3-4). This allows us to assess how a seasonal change in demand affects milk markets. As seen from Table 3-2, we observe that a higher concentration of Orthodox Christians in an enumeration area makes households less likely to consume milk, irrespective of their religious affiliation. For those households that indicated to have consumed milk in the week prior to the interview, we find that these households are significantly less likely to buy this milk from the local market if the concentration of Orthodox Christians rises in the enumeration area. Only Muslim households are increasingly likely to source milk from purchase in dominantly Orthodox settings as compared to Orthodox households. This seems to suggest that due to repeating fasting spells, local milk market development in such settings is hampered.

Table 3-6: Results from a Probit model modelling the likelihood to source consumed milk from purchase for those households that indicated to have consumed milk in the week prior to the interview

	β (SE)
Religious affiliation (<i>Orthodox Christian omitted</i>)	
Protestant	-0.05 (0.32)
Muslim	-0.22 (0.31)
Other	0.44 (0.43)
Interview period (<i>non-fasting omitted</i>)	
Fasting	-0.62 (0.51)
EA Orthodox concentration	-0.78 (0.37)**
Interaction (religious affiliation * interview period) (<i>Orthodox Christian omitted</i>)	
Protestant * fasting	-0.02 (0.59)
Muslim * fasting	0.59 (0.54)
Other * fasting	-0.03 (1.03)
Interaction (religious affiliation * EA Orthodox concentration) (<i>Orthodox Christian omitted</i>)	
Protestant * EA Orthodox concentration	0.71 (0.70)
Muslim * EA Orthodox concentration	1.26 (0.61)**
Other * EA Orthodox concentration	-2.18 (1.89)
Interaction (interview period * EA Orthodox concentration) (<i>non-fasting omitted</i>)	0.95 (0.63)
Interaction (religious affiliation * interview period * EA Orthodox concentration) (<i>Orthodox Christian omitted</i>)	
Protestant * fasting * EA Orthodox concentration	-0.13 (1.13)
Muslim * fasting * EA Orthodox concentration	-0.99 (1.01)
Other * fasting * EA Orthodox concentration	2.76 (3.60)
Household controls	Yes
Locations controls	Yes
n	1,700
Log likelihood	-575.47
Pseudo R ²	0.50

Note: ***, ** and * represent statistical significance at a probability of less than 1%, 5%, and 10% respectively.

5. Discussion and conclusion

Using country wide data from the LSMS, we accentuate the so far underexplored impact of religiously inspired consumption rituals. We study the impact of fasting rituals among Orthodox households not only on consumption decisions, but also on sourcing strategies of consumed milk. Including consumption and sourcing patterns of households of different religious affiliations in the study allows us to account for spill-over effects across the society. We are the first to detail this impact of Orthodox fasting at the national level – other studies performed in the country are limited to case studies of a few villages or cities – and across the different religious groups in the country.

In this chapter, we addressed the following three research questions: (1) do Orthodox households limit their milk consumption during fasting and will they limit their milk consumption more when surrounded by an increasing density of Orthodox Christians?; (2) do non-Orthodox households limit their milk consumption during fasting?; and (3) does fasting limit the market development and thus the consumption outside fasting periods?

Our results show important impacts of fasting. First, fasting reduces the likelihood of Orthodox households to consume milk by more than one-third as compared to non-fasting periods, *ceteris paribus*. An increasing concentration of Orthodox Christians is not associated with a larger impact of Lent fasting on Orthodox households' probability to consume milk, suggesting that there is no difference in the strictness with which Orthodox households adhere to fasting practices between Orthodox minority or Orthodox majority settings, at least not for the Lent fast period. Furthermore, fasting especially impacts Orthodox households who have no young children (aged 0-6 years), whose probability to consume milk is cut by two-thirds during Lent fast.

Second, fasting rituals not only affect the practicing Orthodox group, but spill over to other religious communities, and in particular to the Ethiopian Muslim community. Such an impact was not found among Protestant households – we rather observe an opposite trend – which seems to suggest that fasting norms mainly spill over to the Muslim community.

Third, we find evidence that increasing densities of Orthodox Christians significantly reduce the probability to consume milk, irrespective of the religious affiliation of households and both during and outside fasting periods. As such we find that a 1% increase in Orthodox concentration reduces the probability of a household to consume milk by 10 percentage points, *ceteris paribus*. We find that if households consume milk in such settings, they are significantly less likely to source this milk from the market. These observations point to hampered local market development and reduced milk availability in dominantly Orthodox settings which impact milk consumption among Orthodox and non-Orthodox households even outside fasting periods.

Based on these findings, we argue that religious values and practices – along with other factors – lie at the root of the observed low and stationary consumer demand for animal produce in the country and contribute to an intentional demand seasonality. Further research is imminent, which can also address the limitations that our study faces.

The consumption records used in this chapter are cross-sectional and recall data, which obviously have some shortcomings. Even though the LSMS data are not intended to map the impact of fasting (as it focuses on collecting multi-topic panel household level data to improve agricultural statistics), this lack of focus on fasting proved to be beneficial as it reduces the chance that respondents answer consumption questions in a socially desirable manner. The way in which the survey was implemented allowed us to construct a fasting indicator that labelled a household record as fasting if at least part of the seven-day recall period coincided with the official Lent fast period, and non-fasting otherwise. Because the LSMS data are cross-sectional this implies that the households whose consumption data were gathered during the Orthodox Lent period are not the same as those households interviewed outside Lent. This could lead to potential biases, which we assume to be small given the random sampling procedure employed during the LSMS data collection. By including households and location controls in our analyses, we further control for potential biases.

Ideally one would compare the consumption data of the same household both within and outside the Lent fast period. We tried to construct panel data, using the data from the third LSMS wave in Ethiopia (2015-2016). Yet, the LSMS data are not intended to compare food intake of households during and outside an Orthodox fasting season, therefore only few households could be properly matched, making the sample not nationally representative anymore. Follow-up studies would benefit from focusing on a cohort of households before, during, and after fasting, using (supervised) diaries to map consumption at household member level and incorporate information on households' actual involvement in religiously inspired rituals, such as fasting. Although such data are obviously more detailed than the recall data we use, it might become more complex to control for social desirability bias, especially among Orthodox households. Moreover, further research is needed to assess more detailed the impact of fasting on the milk market and the milk supply chain actors. We address this later on in this dissertation (Chapter 4 and 5).

Our research adds important insights to the literature. Most research so far focused on religion and food habits and consumer choices in a Western context and mainly looked at Islamic traditions, while food habits are especially prevalent within African societies. Our research addresses religiously inspired food habits in the context of Ethiopia and shows that such habits not only affect food consumption patterns but also seem to impact food production and market development. The impact of religiously inspired food habits is not limited to the practicing group but increasingly spills over to other religious groups, the more dominant the practicing group becomes. Still, more studies are required to assess the societal impact of religion on food systems by studying other religious

practices and settings. Moreover, future studies should try to map through which pathways religion impacts various consumer groups to better understand why we observe a differential impact of Orthodox fasting on the Muslim and Protestant community.

Our results invite the policy question of how to mitigate the impact of Orthodox fasting on the dairy supply chain, which we discuss further and more in-depth throughout the next chapters. Ethiopian policy makers should be aware of this broader societal impact of Orthodox fasting, which is now insufficiently accounted for in the livestock programme. Our study presents evidence that religious practices can have negative repercussions on the development of an effective functioning milk value chain. Orthodox fasting lowers the demand for milk and milk products, which in turn adversely affects the sales opportunities of dairy producers and retailers. Such demand-side inefficiencies should be addressed and accounted for in order to promote the development of agriculture and food production, notably the Ethiopian dairy sector in this specific case. We can expect that religious values and related fasting practices will persist in the near future, since religion is rather static and steadfast while factors such as income, urbanization, and population are dynamic.

We provide three examples of soft measures that may mitigate the impact of Orthodox fasting, in the belief that hard measures, such as the prohibition of fasting practices in consumption, are unlikely to be accepted by the Ethiopian society and are therefore bound to fail. First of all, dairy producers can try to cope with Orthodox fasting by overlapping cows' dry periods with Orthodox fasting. However, given the multiple fasting periods within the Orthodox community that are scattered throughout the year, such a strategy may at best only partially tackle the demand–supply mismatch. Second, the government might create alternative market outlets for dairy products during fasting periods, for example by expanding school milk programmes. Since children below the age of seven are exempt from fasting, such programmes could be a very effective policy action not only to lower the demand–supply mismatch during Orthodox fasting, but also to improve food security and adequate nutrition amongst children. Finally, the government might invest or incentivize private investors to invest in strategies that structurally raise the shelf life of milk and milk products to overcome the fasting periods through the accumulation of a stock of milk produce. Specifically, efforts to stimulate the further development and adoption of dairy conservation and processing technologies are needed. To date, processing is largely small-scale using traditional methods. Only 40 industrial-scale dairy processors are operating in the country (although often below their optimal capacity), and these are located principally around the capital Addis Ababa. Moreover, it has been reported that during Orthodox fasting, these dairy processing plants reduce their supply of milk by requiring higher quality or paying lower prices to their milk suppliers [201].

CHAPTER 4

Fasting, food, and farming: Evidence from Ethiopian milk producers

This chapter is based on:

D'Haene, E., Vandevelde, S., and Minten, B. (2020) Fasting, food, and farming: Evidence from Ethiopian producers on the link of food taboos with dairy development. Ethiopia Strategy Support Program Working Paper No. 141, International Food Policy Research Institution (IFPRI) and Ethiopian Development Research Institute (EDRI).

Abstract

The impact of widely present food taboos on consumption and the functioning of food value chains is understudied and not well understood. In the case of Ethiopia, religious fasting by Orthodox Christians is seen as an important impediment for the required higher milk consumption (especially by young children) and for the sustainable development of a competitive dairy industry. However, empirical evidence on the effects of fasting in this environment is limited. Relying on unique producer data, we shed light on the impact of fasting on production, marketing, and consumption decisions in dairy farming households in a dominantly Orthodox and commercially-oriented setting. Using a combination of Ordinary Least Square and Seemingly Unrelated Regression Equation models, we find that farmers adopt a combination of different strategies to overcome periods of slack demand and the importance of these strategies varies with how far these farmers are located from the capital of Addis Ababa. Our results call for further investment infrastructure facilities to integrate markets, as well improved processing and storage so as to mitigate the impact of fasting on the dairy value chain.

Keywords: adaptation strategies, child milk consumption, milk producers, Ethiopia, fasting, Great Addis milk shed

1. Introduction

Since ages people practice religion through food choices as various religious groups lay out food recommendations to their adherents [301]. Yet, the role of religion in shaping food choices and the food supply chain is not well understood [5], while it is believed that the impact of religion on food system development will remain important, especially given the growing share of religious people worldwide [302]. Religious practices are especially prevalent for ASFs [69], possibly leading to lower consumption, less availability, and higher prices of such products. This is unfortunate as a strong link has been shown worldwide between the consumption of ASFs on the one hand and improved nutritional outcomes on the other hand [27, 303, 304].

In the previous chapter, we detailed the impact of fasting on a household's decision to consume milk. We showed that fasting practices not only affect the practicing Orthodox community, but spill over to other religious groups, especially in dominantly Orthodox settings. The religiously-induced demand seasonality impacts the development prospects of the dairy sector in the country and can therefore not be neglected. In contrast to the rapid growth in crop output and productivity recorded in Ethiopia, ASF output has grown slowly and productivity has stagnated, seemingly due to low availability and adoption of improved inputs in the sector [31]. Yet, the widespread occurrence of fasting practices in the country could possibly have prohibitive effects on investments in the dairy sector thereby impacting availability and pricing of milk. Fasting practices in the country could thus contribute to the underdevelopment of the dairy sector as compared to other dairy sectors in the region [13, 18].

Milk demand seasonality in Ethiopia affects all actors along the supply chain, i.e. retailers, processors, and milk producers. Yet, few studies have detailed how supply chain actors cope with periods of reduced demand for milk. The few, mostly qualitative studies that exist detail reduced activities of retailers and processors during fasting periods, see for example Avery [202] and Land O'Lakes [200]. Industrial processing companies have been shown to cut down their capacity during fasting periods by 25% by limiting the supply of milk using quota systems, paying lower prices, and/or requiring a higher milk quality [12, 201]. A small fraction of these processors has managed to adapt by building up stocks of processed milk products that they can sell outside the fasting period or transport to areas where fasting is less prevalent [200]. Since end consumers, retailers and processors limit the quantity of milk purchased, fasting necessarily also affects the milk producers. Anecdotal evidence shows that many producers indicate a reduced or even a complete lack of market access as well as lower prices during fasting [13, 199, 305]. Focus group discussions with farmers selling to cooperatives and/or processors revealed that farmers are confronted with drops in prices for milk of 18-56% during long fasting periods [12, 199]. Farmers face reduced milk sales with sales volumes being reported to decline by 20-25% during fasting seasons [42]. Driven in part

by this culture of fasting that reduces market opportunities of milk during fasting, traditional processing at the level of the primary producer is widespread in Ethiopia [42].

Fasting thus seems to create excess milk at the farm-level, hence one might wonder whether children, who are – in principle – exempt from fasting, benefit from this excess milk. Previous studies have illustrated negative repercussions of fasting on dietary diversity and intake of animal proteins for children [213, 214, 306]. Even when ASFs are available, caregivers are reluctant to feed them to their children during Lent, either because they believe children should participate in fasting rituals or because they fear objection of neighbours, and/or contamination of cooking utensils with non-fasting foods [306]. These trends are worrisome given the low dietary diversity and ASF consumption even outside fasting periods for children. According to the Ethiopian Demographic and Health Survey of 2016, only 14% of the children aged 6-23 months old received diets that met the recommended minimum dietary diversity score. Only 14% of the children under the age of two that are not breastfed, consumed meat, fish, or poultry while this drops to 8% for breastfed children. Although milk intake is somewhat higher, it is still low – 13% for the breastfed children and 24% for non-breastfed children [307]. The low inclusion of ASFs in children's diets is believed to be a main driver, among other factors, of the high prevalence of malnutrition in SSA [23].

Despite these trends being reported, there is still limited quantitative evidence on the value chain effects of fasting and specifically on the adjustments made by producing households to overcome periods of reduced demand. Particularly important here is to detail the impact of fasting on children's milk intake in dairy farming households. Additionally, no attention has been paid so far to the differential effects fasting might have depending on the degree of market access of milk producing households.

We aim at filling these voids. The main objective of this chapter is to investigate how fasting impacts production, marketing, and consumption decisions of milk producing households in the dominantly Orthodox and commercially-oriented setting of the Great Addis milk shed. Many farmers in this milk shed have established specialized milk production systems and these farmers mainly produce for the market, while the remaining milk is used to satisfy own household needs (see also Chapter 2, Section 3.1). We rely on cross-sectional data collected by a programme led by IFPRI that aimed at mapping the supply chain of milk to the capital city of Addis Ababa. The survey covers recall data that partially overlap with two fasting periods, i.e. Lent fast and Christmas fast, which allowed us to construct fasting indicators, as we did in the previous chapter. The programme interviewed milk producing households located in two commercially-oriented dairy zones close to the capital Addis Ababa, i.e. North and West Shewa. The impact of fasting in these zones is expected to be big, given the majority of Orthodox Christians residing in these zones (75% on average). Detailing the impact

of fasting on these commercially-oriented dairy producing households is crucial so as to formulate fit interventions that aim at sustainably developing a competitive dairy industry.

We are specifically interested in answering the following four research questions: (1) how does fasting impact total milk production at the farm, as well household decisions to allocate produced milk to different uses: i.e. own consumption, processing, and sales; (2) does fasting reduce sales volumes of liquid and processed milk?; (3) how does fasting impact milk consumption volumes in producing households, and especially the consumption of milk by young children?; and (4) does the impact of fasting on production, sales, and consumption vary with market access?

Overall, we find that farmers in this milk shed have specialized in liquid milk sales, due to the lack of value addition that can be created when processing milk, as farmers use traditional processing techniques and materials making the process labour-intense and input-inefficient [13, 236]. Long fasting seasons reduce the market opportunities for liquid milk, yet the way farmers have adapted to these reduced market opportunities differs with their degree of market access, which we proxy in this chapter by remoteness of the households to the capital Addis Ababa. We find that remote farmers mainly rely on reducing the production of milk by their dairy herd during long fasting periods. The milk that is still produced by these households is processed or channelled to their young children. As a result, these households sell significantly smaller quantities of liquid milk during fasting periods, but we observe no effect of fasting on sales volumes of processed milk. While these households overall consume significantly less liquid and processed milk during long fasting periods, the intake of milk by their youngest children is not affected by the presence of a long fasting period. The youngest children seem to be the ones that still consume milk during fasting periods. Liquid milk sales opportunities of non-remote farmers on the other hand are significantly less affected by long fasting periods. But we observe considerable heterogeneity among these farmers in their ability to maintain milk sales during fasting seasons. Some of these farmers seemingly benefit from being better connected to buyers that continue purchasing milk during fasting periods. As a result, non-remote farmers, on average, do not reduce the total production of milk at their farms significantly. Yet, to compensate for (some) forgone market opportunities during fasting, these farmers process a significantly larger share of the produced milk during fasting and they feed significantly more milk to their young children. As opposite to remote farmers, consumption volumes of liquid and processed milk in non-remote households are not affected by long fasting seasons.

Our findings contribute to literature by detailing quantitatively how fasting impacts production, marketing, and consumption decisions among commercially-oriented milk producing households in a dominantly Orthodox setting. We show that the impact of fasting on milk marketing by producing households depends on the degree of market accessibility and that fasting practices are beneficial for most young children in dairy farming households.

Our findings have a number of important implications. First of all, we find that household intake of milk remains low, even when milk is available at the household level, and that milk is mainly channelled to young children. Still, the intake of milk by young children in these producing households does not meet the required intake for healthy diets as laid out by Willett et al. [23]. Nutritional awareness creation is thus needed to increase the intake of milk in these dairy farming households by all members outside fasting periods as well as during fasting periods for those members that are exempt from fasting. Second, further investments are needed to intensify milk production systems and increase milk productivity so that more milk becomes available at lower prices. As long as milk remains a luxury product, nutritional awareness creation will not be sufficient to make producing households consume more milk, especially outside fasting periods. Such investments however will only be attractive to producing households if the effects of seasonal demand swings are smoothened. Therefore, further efforts are needed towards (1) improving transportation facilities to assure market integration and marketing to areas where fasting is less prevalent especially to link remote farmers better to milk markets during fasting, (2) enhancing processing practices so that more milk is being processed during fasting seasons, as well as (3) ensuring availability of improved (cold) storages to stock processed milk products during periods of slack demand.

2. Demand seasonality, producer adaptation strategies, and market development

Demand and supply of food produce in developing nations are affected by a number of factors. As such the quantity of food produce that consumers are willing to purchase from the market depends on various factors, among others the price of the food product and the prices of competing food products, tastes and preferences, income, number of consumers, and the range of food products available to consumers. The quantity that producers supply on the other hand is affected by the price of the product on the market, the costs of production, technology, climate, storage possibilities, and their own consumption to name a few.

Consumer demand changes constantly, both in the short-term and in the long-term. Short-term changes in food demand can be caused by weather¹⁴ and festivities, while long-term changes are caused by changes in preferences, attitudes, and society. In the case of Ethiopia, fasting practices by the large Orthodox community create recurrent short-term changes in milk demand – with reduced demand during fasting periods – but simultaneously depress long-term milk demand as well, especially in areas where large concentrations of Orthodox Christians reside (see Chapter 3).

Such trends in demand ultimately affect market development. In Chapter 3, we found evidence that the local milk market development is hampered in dominantly Orthodox settings. The prevalence of fasting practices seems to impact the availability of milk in these settings and milk producers might invest less in their dairy farms because they lack stable and predictable outlets for their milk.

In this chapter, we study the impact of fasting on the milk market in the Great Addis milk shed, the most developed milk shed in the country. Producers in this milk shed benefit from being located close to the capital of Addis Ababa, the largest and most affluent population centre of Ethiopia [245]. While the average per capita consumption of liquid and processed milk reaches 20 litres in the country, this rises to 52 litres per capita in Addis Ababa, due to the larger concentration of high-income households as well as foreigners [201]. The Great Addis milk shed offers different market outlets for milk producers who not only sell their milk directly to individual consumers, but also to traders, cooperatives and unions, processors, and FSPs. Many farmers in this milk shed thus have established specialized milk production systems and liquid milk sales. These farmers mainly produce for the market, while remaining milk is used to satisfy their own household needs (see also Chapter 2, Section 3.1). Yet, also here, Orthodox fasting practices impact the dairy value chain given the large concentration of Orthodox Christians (75% of the population).

¹⁴ This also holds for Ethiopia and van der Valk and Tessema [243] report that people tend to consume less milk when it is rainy and cold.

We conceptualize the impact fasting on producer adaptation strategies and milk market development for the Great Addis milk shed relying on a simple demand and supply framework for liquid and processed milk.

During non-fasting periods, prices and quantities meet at an equilibrium price, P_{NF} and P^*_{NF} , and quantity, Q_{NF} and Q^*_{NF} , in the liquid and processed milk market respectively (Figure 4-1). Abstinence from dairy products by some people in Ethiopia during the fasting period leads to a shift downward in the overall demand curve for liquid milk – from D_{NF} to D_F – and processed milk – from D^*_{NF} to D^*_F . If the supply of liquid milk stays constant during fasting periods, prices of liquid milk would drop to P_F making the liquid milk more accessible for those people that do not fast. Yet, what seems more likely, also based on earlier findings of qualitative studies, is that the supply of liquid milk on the market adjusts as well during fasting periods. Sales volumes of liquid milk might decrease (1) because producers decide to reduce total milk production at the farm by feeding cows poorer quality diets during fasting and/or drying off their milking cows¹⁵, and/or (2) because producers increasingly transform the liquid milk to a more storable product (e.g. butter), and/or (3) because producers consume more milk themselves, especially when they have young children. During fasting periods, increased consumption by young children in these households might become more interesting due to the reduced marketing opportunities for milk. In all three cases, on top of liquid milk demand shifts, there will be a shift in the supply curve of liquid milk – from S_{NF} to S_F . A simultaneous reduction in the supply of liquid milk, on top of a demand shift, reduces the impact of fasting on the market prices of liquid milk, as can be seen in the smaller differences between $(P_{NF} - P'_F)$ than $(P_{NF} - P_F)$.

The impact of fasting on the market for processed milk, will depend on the decisions made by dairy farming households. Farmers in this milk shed have specialized in liquid milk sales and the surplus milk is consumed and/or processed. Therefore the supply of processed milk depends on the decisions made by producing households on what to do with the liquid milk that cannot be sold during fasting periods. If the majority of the farmers decides to increasingly process produced milk to more storable milk products during fasting, a supply shift in the market of processed milk products will occur to the right – from S^*_{NF} to S^*_F – putting extra downward pressure on prices of processed milk that are now reduced from P^*_{NF} to P^*_F ¹⁶. Increased processing of liquid milk will thus magnify the

¹⁵ Part of the Orthodox fasting events coincide with periods of potential feed shortage problems (see Figure 2-8, Chapter 2). This is most obvious for the Apostles fast, which overlaps with the lean season during which the probability of acute feed shortages is high. But also during Lent fasting, feed availability continuously decreases causing economically rational producers to reduce milk production during this period. However, given that the multiple fasting periods within the Orthodox community are scattered throughout the year, such a strategy may at best only partially tackle the demand–supply mismatch.

¹⁶ The expected downward pressure on prices in processed milk markets is partly explained by opportunity costs for the storage of processed milk products and should in more complete models be addressed by more sophisticated storage models and costs of processing and storage (such as in e.g. Williams and Wright [308]). However, these considerations are beyond the scope of this analysis.

effects of fasting in the market of processed milk. On the other hand, if the majority of farmers decides to reduce total milk production on the farm and/or increasingly consume the milk themselves, we expect to observe a supply shift to the left instead of the right in the market of processed milk products – from S^*_{NF} to S^{**}_F – and price swings caused by fasting will be lower ($(P^*_{NF} - P^{**}_F)$ instead of $(P^*_{NF} - P^{*'}_F)$).

We expect to find divergent fasting adaptation strategies by farmers who have differential access to the Addis Ababa milk market. We hypothesize that farmers who are located closer to the capital and who are thus better connected to and integrated in the Addis Ababa milk market, will be more likely to continue supplying milk to the market during fasting periods. These farmers probably benefit from being better connected to buyers that assure stable purchase volumes of milk both during and outside fasting periods (e.g. processors, FSPs, and individual, non-Orthodox consumers). We expect that the impact of fasting demand will be smaller in both the liquid and processed milk market in the area close to Addis Ababa, which reduces the impact on the supply of liquid milk as well as the supply of processed milk. Farmers who are far from the capital and who face higher transaction costs to market their produce, especially during fasting periods, face a higher risk of not being able to sell their liquid milk during fasting periods. To reduce this risk, these farmers can opt to reduce total milk production, process the liquid milk to milk products with a longer shelf life – that can be stored and consumed or sold when demand rises again – and/or feed more milk to their young children. These actions will cause a larger supply shift on the liquid milk markets in these areas. Increasingly using the liquid milk for own consumption (and especially to feed young children) helps producers to reduce the impact of fasting on demand by internalizing the value of milk within the household. If liquid milk is increasingly processed, the supply curve of processed milk will shift to the right. Still, producers might wait to sell the processed milk products to avoid too large price drops for processed milk products.

The simple diagrams give an indication of the forces at play because of fasting. The predicted effects all depend on the magnitude of fasting adherence of the population at large and the level of market integration, as they determine the size of these demand and supply shifts. Of interest in this chapter is to study how producers deal with the changes that are induced by fasting. The purpose of this simple conceptual framework is to help set the stage for some of the expected results of our analysis. First, we expect that the supply of liquid milk on the market will adjust during fasting periods and that particularly remote farmers will decide to reduce their sales volumes. Second, consumption of milk by those not affected by fasting (i.e. children below the age of seven) is likely to go up because reduced market opportunities for liquid milk and price decreases.

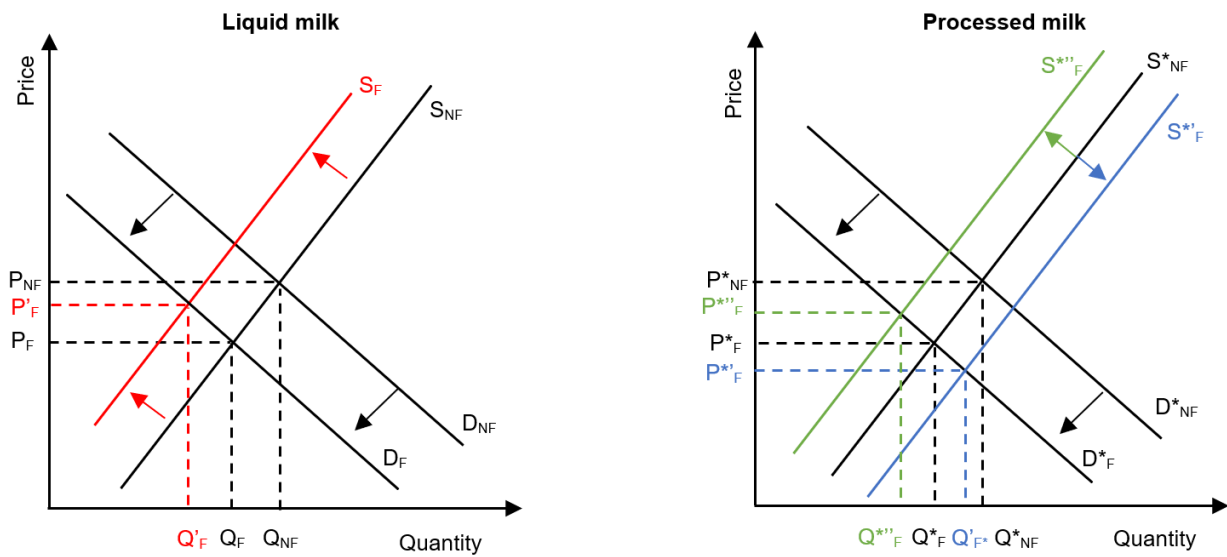


Figure 4-1: Demand and supply framework illustrating the impact of fasting on the liquid milk and processed milk markets

3. Materials and methods

3.1. Data

We use unique data collected within the project ‘Improving the evidence and policies for better performing livestock systems in Ethiopia’ led by IFPRI as part of the Feed the Future Innovation Lab for Livestock Systems. Data collection was focused on the zones of North and West Shewa as dairy production in these zones is the highest of all surrounding zones of Addis Ababa. Stratified random sampling was employed to select milk producing households, focusing on three strata: producers in the city of Addis Ababa, suburban producers and rural producers. More details on the sampling procedure can be found in Supplementary material B.1¹⁷. 870 milk producing households with at least one cow in milk were surveyed during January 22 and February 15, 2018 – 30 urban, 240 suburban, and 600 rural producers. Face-to-face interviews were conducted in the local language and data were recorded by enumerators on paper. The survey collected information on household characteristics, details on cows and dairy activities, as well consumption volumes (for the household as a whole, but also for the youngest child below the age of five separately)¹⁸.

¹⁷ We also compared the dairy farming households in our sample with Addis Ababa sub-sample of the LSMS, more details are found in Supplementary material B.2.

¹⁸ The survey also detailed fasting adherence by individual household members and beliefs about fasting adherence of young children, we detail these data descriptively in Supplementary material B.3.

3.2. Methodological approach

To study how fasting affects production, marketing, and consumption decisions of dairy farming households, we constructed two fasting indicators. We needed two fasting indicators so as to accommodate for the fact that production and marketing variables were recorded using a recall period of one month prior to the interview, while consumption variables were recorded using a recall period of one week. First, we calculated for each household surveyed, the number of consecutive official fasting days in the month and week prior to the interview using the official fasting calendar as reflected in Table 4-1. The number of consecutive official fasting days in the past month varied between 3 to 17 days and those in the past week between 1 to 7 days. A cut-off was set at the average amount of consecutive fasting days in the past month and past week so as to distinguish between short and long fasting episodes. By dividing the sample in this way, we construct two dummy variables with the variables being equal to one if the number of consecutive official fasting days in the past month or past week prior to the interview is at least 10 or 4 days respectively, zero otherwise.

Table 4-1: Timing of official fasting periods and data collection

Dates	28/11/2017 - 06/01/2018	07/01/2018 - 21/01/2018	22/01/2018 - 28/01/2018	29/01/2018 - 31/01/2018	01/02/2018 - 11/02/2018	12/02/2018 - 25/02/2018	26/02/2018 - 07/04/2018
Fasting	Advent	Weekly only		Nineveh	Weekly only	Lent	
Data collection							

Besides fasting, we identified other explanatory variables that have been shown to impact dairy production and marketing [309-312] as well as dairy consumption [6, 297-299]. These studies show the importance of including the following household characteristics: age, gender, schooling, and marital status of the household head; religious affiliation and ethnicity of the household; household size and composition; household income; number of local cows and number of crossbreed cows owned; cooperative membership; total milk production by milking cows¹⁹; and households' access to markets (in our case the Addis Ababa market). We proxy market accessibility by remoteness to Addis Ababa²⁰, assuming that households located closer to the capital have better market access. Additionally, we include within-sample concentrations of Orthodox Christians in the village where a household resides. We found in Chapter 3 that the religious diversity in the immediate vicinity of a

¹⁹ Total milk production was not included in the regressions modelling daily milk production at the farm.

²⁰ The variable is defined and calculated in line with Vandecasteele et al. (2018) using the Ethiopian road network and quality data (obtained from the Ethiopian Road Authority) combined with the farmer's self-reported travel time to the nearest road segment. The obtained measure thus captures the travel time (expressed in hours) from the farm's location to Ethiopia's capital city.

household, and particularly the concentration of Orthodox followers, impacts milk consumption and most likely also affects milk production and milk output use decisions.

We start by detailing the impact of fasting on total milk production at the farm and decisions of households to allocate produced milk to different uses: i.e. own consumption, processing, sales, and/or giving the milk away. In the survey, producing households were asked to detail how much milk was produced by their dairy herd in the month prior to the interview as well as how much of this produced milk was sold, processed, consumed, and/or given out²¹. We use an OLS regression to assess the impact of a long fasting period on the daily milk production at the farm in the month prior to the interview (P) while a Seemingly Unrelated Regression Equations (SURE) model is employed to assess the impact of fasting on the shares of produced milk being sold (S_s), processed (S_p), consumed (S_c), and/or given out (S_g). The OLS (eq. 1) and SURE (eq.2) models are defined as follows:

$$P = \alpha_0 + \alpha_1 F + \sum_j \alpha_j X_j + \varepsilon \quad \text{eq. 1}$$

$$\begin{cases} S_s \\ S_p \\ S_c \\ S_g \end{cases} = \beta_0 + \beta_1 F + \sum_j \beta_j X_j + \varepsilon \quad \text{eq. 2}$$

F refers to the constructed fasting indicator, while X_j is a set of j explanatory variables which includes a list of household controls as summarized above (we descriptively detail these variables in Section 4.1, Table 4-2). ε is the random error term that is clustered at the village level.

Having studied the impact of fasting on total milk production and produced milk output decisions, we further detail how a long fasting season impacts the transaction/sales volumes of milk (T_m), butter (T_b), and cheese (T_c) during the month prior to the interview²². Also here we employ a SURE model since the transaction volumes decisions are interrelated. The model is defined by:

$$\begin{cases} T_m \\ T_b \\ T_c \end{cases} = \gamma_0 + \gamma_1 F + \sum_j \gamma_j X_j + \varepsilon \quad \text{eq. 3}$$

²¹ Wastage of milk and related products is not really an issue in our sample. A recent study by Minten et al. [313], using the same producer data as this chapter, assessed that the percentage of all produced milk being spoiled at farm level was as little as 0.003–0.008%.

²² We did not consider the sales of buttermilk since buttermilk is usually not sold in the market. Produced buttermilk is fed to the calves, consumed by adult household members, and/or processed further to produce a soft cottage cheese, called *ayib*.

We additionally ran double-hurdle models to assess whether fasting impacts producer decisions to sell liquid or processed milk – i.e. the participation decision modelled by T' – and/or sales volumes if producers decided to sell liquid or processed milk – i.e. the quantity decision modelled by T^* . The double-hurdle models are defined by:

$$T^* = \theta_0 + \theta_1 F + \sum_j \theta_j X_j + \varepsilon \quad \text{with } T^* \text{ observed only if } T' = \varphi_0 + \varphi_1 F + \sum_j \varphi_j X_j + \mu > 0 \quad \text{eq. 4}$$

To detail the impact of fasting on household consumption volumes of liquid milk (C_m), butter (C_b), cheese (C_c), and buttermilk (C_{bm}), we again apply a SURE model, defined as:

$$\begin{cases} C_m \\ C_b \\ C_c \\ C_{bm} \end{cases} = \delta_0 + \delta_1 F + \sum_j \delta_j X_j + \varepsilon \quad \text{eq. 5}$$

Since we expect that the impact of fasting will be different for young children in milk producing households, we assess the impact of fasting on the liquid milk consumption of children ($C_{m,child}$) in a separate OLS regression. In the survey, respondents were asked to map separately the intake of liquid milk by the youngest child below the age of five in the week prior to the interview. For this latest regression, the list of explanatory variables is extended with child-specific controls ($X_{child,j}$), i.e. age, gender, whether the child is breastfed and whether the child received vitamins or oral rehydration salts (ORS). Including vitamin supplementation allows to control for the level of nutrition knowledge of the household. Research in Ethiopia has shown that better nutrition knowledge significantly improves children's dietary diversity with children being more likely to have consumed ASFs [314]. Including supplementation of ORS on the other hand allows to control for whether or not the child was sick, which could potentially reduce their intake of milk. The model is defined by:

$$C_{m,child} = \eta_0 + \eta_1 F + \sum_j \eta_j X_j + \sum_j \eta_j X_{child,j} + \varepsilon \quad \text{eq. 6}$$

Having detailed the impact of fasting on production, marketing, and consumption decisions, we further explore in a second stage, the potential heterogeneity in adopted adaptation strategies by producing households. We specially focus on heterogeneity dependent upon the household's degree of market access. We therefore categorize producers in two groups, remote and non-remote, using the median of 1.54 hours travel time to Addis Ababa as a cut-off between the two groups. For both groups, remote and non-remote producing households, we re-estimated the models as laid out above but now for each group separately. We tested a full-sample approach by including interaction

effects with the variable remoteness, yet this approach did not improve the analytical power. Therefore, we restrict the reported results to those of the split-sample analysis.

Finally, to assess how fasting adaptation strategies of dairy farming households affect the market of both liquid and processed milk, we descriptively look into dairy prices reported by milk producing households. In one part of the survey, respondents were asked to detail average market prices for liquid milk, butter, and cheese during different specified time spans over the 12 months preceding the survey: (1) in the middle of Lent fasting, (2) during Easter feast, (3) the period after Easter until May, (4) June until the beginning of Advent fasting, (5) in the middle of Advent fasting, (6) during Christmas festivities and finally (7) in the period after Christmas until the time of the survey. To descriptively appraise price effects linked with fasting, we construct two-way graphs that display market prices for liquid milk, butter, and cheese over the different specified time spans. Yet, the prices reported by farmers might mask larger fluctuations as the price questions included in the survey ask farmers to detail average prices over quite large time spans. Later in the survey, farmers were asked to report the prices they obtained for liquid milk, butter, and cheese that they sold in the middle of the most recent long fasting season and two weeks after this fasting season, when they had cows in milk. Taking the difference between both prices might give a more clear indication of the price swings at stake. Furthermore, we also studied whether remoteness causes larger price swings.

4. Results

4.1. Descriptive statistics of producing households

An overview of the dependent variables, the constructed fasting indicators, and explanatory variables is found in Table 4-2.

Average daily milk production in our sample is 6 L per producing household. 55% of this produced milk is processed into cheese, butter, and/or buttermilk, 25% is sold, 19% is used for own consumption, and a minor share (0.5%) is given away. Sales volumes vary considerably for all products. Still, it can be observed that producers have specialized in milk sales with 124 L of liquid milk being sold monthly on average, while butter and cheese sales volumes only reach 1 kg and 8 kg respectively. Processing at the farm level is thus mainly intended for own consumption.

Liquid milk and processed milk consumed within the households are almost exclusively sourced from own production (99.8% on average). Average household liquid milk intake fluctuates around 3 L in the week prior to the interview, of which the youngest child consumes on average 2 L. Our data thus confirm that young children are prioritized when it comes to milk consumption, which is in line with the prevailing assumption in Ethiopia that milk is mainly meant for children [315]. Buttermilk, on the other hand, is mostly consumed by other household members – mostly women and elderly [316].

In our sample, 31% and 60% of the households is confronted with a long fasting period in the last week and month respectively. The difference can be explained by the presence of the Advent fasting period, which is covered in the monthly fasting indicator, but not in the weekly indicator.

Table 4-2: Descriptive statistics of the dependent variables, the constructed fasting indicators, and explanatory variables used in the analyses

	Unit	Household	Youngest child
Dependent variables			
Past month			
Milk production	L/day	6.08 (16.18)	-
Share produced milk home processed	%	54.98 (37.83)	-
Share produced milk sold	%	25.62 (40.31)	-
Share produced milk home consumed	%	18.78 (21.74)	-
Share milk given out	%	0.50 (3.59)	-
Sales quantities past month			
<i>Liquid milk</i>	L	123.9 (351.70)	-
<i>Butter</i>	kg	1.08 (2.87)	-
<i>Cheese</i>	kg	7.90 (31.18)	-
Past week			
Consumption			
<i>Liquid milk</i>	L	3.16 (4.44)	2.04 (2.67)
<i>Buttermilk</i>	L	1.70 (3.30)	-
<i>Butter</i>	L eq.	2.16 (5.79)	-

	<i>Cheese</i>	L eq.	1.64 (3.57)	-
Weekly fasting indicator		0/1	0.31	0.28
Monthly fasting indicator		0/1	0.60	-
Household controls				
Sex household head: male		0/1	0.92	-
Age household head		years	48.95 (13.71)	-
Schooling household head		years	3.76 (4.27)	-
Marital status household head: married		0/1	0.91	-
Marital status household head: widowed		0/1	0.06	-
Marital status household head: divorced/separated		0/1	0.02	-
Marital status household head: single		0/1	0.01	-
Monthly household income		'000 ETB	3.68 (4.52)	-
Infants (<1 year old)		#	0.08 (0.28)	-
Children (1-6 years old)		#	0.63 (0.79)	-
Children (7-9 years old)		#	0.52 (0.66)	-
Adolescents (10-19 years old)		#	2.11 (1.52)	-
Adults (20-64 years old)		#	2.44 (1.12)	-
Elderly (65+ years old)		#	0.24 (0.51)	-
Religious affiliation: Orthodox Christian		0/1	0.85	-
Religious affiliation: Protestant		0/1	0.12	-
Religious affiliation: Catholic		0/1	0.01	-
Religious affiliation: Muslim		0/1	0.02	-
Religious affiliation: Traditional faith		0/1	0.00	-
Religious affiliation: Other religion		0/1	0.00	-
Ethnicity: Oromo		0/1	0.86	-
Ethnicity: Amhara		0/1	0.12	-
Ethnicity: Tigrayan		0/1	0.00	-
Ethnicity: Gurage		0/1	0.01	-
Ethnicity: Other ethnicity		0/1	0.01	-
Total milk production		L/month	400 (597)	-
Local cows		#	1.68 (1.61)	-
Cross-bred cows		#	1.14 (2.10)	-
Cooperative member		0/1	0.04	-
Remoteness		hours	1.98 (1.46)	-
Orthodox concentration		%	84.45 (20.64)	-
Child controls				
Age youngest child		years	-	2.01 (1.32)
Sex youngest child : male		0/1	-	0.56
Youngest child breastfed yesterday		0/1	-	0.56
Youngest child vitamins yesterday		0/1	-	0.04
Youngest child ORS yesterday		0/1	-	0.03
n			870	311

Note: When applicable, means are shown with standard deviations in parentheses. For comparison purposes, kilogram (kg) amounts of processed products are transformed into L of milk equivalents. The conversion rates used are 20 L/kg for butter and 1.33 L/kg for cheese. The control variable total milk production is not included in the OLS regression modelling daily milk production at the farm.

4.2. Fasting and production, marketing, and consumption decisions

4.2.1. Producer adaptation strategies

Dairy farmers reduce their total milk production at the farm during long fasting periods by one-fourth on average, yet significant heterogeneity exists around this estimate, with some farmers reducing milk production at the farm more than others (Table 4-3). Still, this reduced milk production indicates that producers are somehow aligning their production strategies with fasting periods. Reduced total milk output is likely to occur during the Lent fasting period, since it coincides with the dry period (Figure 2-8, Chapter 2). Yet, part of the data overlap with the Advent fasting, a period where milk output should be at its highest level given the abundance of feed (Figure 2-8, Chapter 2). Therefore, it seems that reduced milk production is not only the result of reduced feed availability and/or quality, but also that farmers are aligning the number of cows in milk and plan calving so that lactation periods do not overlap too much with periods of slack in demand.

Long fasting seasons reduce marketing possibilities of liquid milk and producers sell a significantly smaller share of the produced milk during these periods. Farmers turn the non-sold milk into products with a longer shelf life and process nearly 60% of their produced milk during long fasting spells (Table 4-3). The share of produced milk being consumed does not change with the presence of long fasting periods. We further observe no change in the already low share of milk being given away (Table 4-3).

Table 4-3: Effect of the presence of a long fasting season in the last month on the milk production at the farm and the output use of produced milk one month prior to the interview

	Milk production at the farm and output use of produced milk last month				
	Total milk production (L/day)	Produced milk sold (%)	Produced milk processed (%)	Produced milk consumed (%)	Produced milk given out (%)
	OLS				
Fasting past month (0/1)	-1.65* (0.96)	-15.65*** (5.04)	15.29*** (4.63)	0.68 (1.68)	-0.32 (0.35)
Controls	Yes	Yes	Yes	Yes	Yes
Non-fasting mean	7.03	40.44	41.66	17.40	0.50
n	855	855	855	855	855
R ²	0.72	0.54	0.42	0.13	0.05

Note: ***, ** and * represent statistical significance at a probability of less than 1%, 5%, and 10% respectively. For a complete list of controls, see Table 4-2. Cluster robust standard errors are in parentheses.

Regarding sales volumes, we find that only liquid milk sales are significantly affected by long fasting periods (p value is 0.056) and reduce on average by 28% (Table 4-4), which confirms the predicted effect from the conceptual model in Section 2. Butter sales seem to go up slightly, while cheese sales are not affected by long fasting seasons (Table 4-4). Liquid milk sales do not completely drop to zero, since a considerable part of the milk buyers continue purchasing milk during Orthodox fasting. This is the case for about 18% of the producers in our sample. For the farmers that continue selling milk during fasting, we find that 48% sells to retailers, 30% to processors and 17% to consumers. Continuing buying milk during Orthodox fasting seasons helps buyers to link them with dairy farmers. As such, Valk and Tessema (246) observed during discussions with small-scale processors in the Great Addis milk shed that some of these processors continue buying milk from their farmer suppliers even if they cut down their processing capacity during fasting. They do so because they fear that producers will stop selling milk to them if they would reduce the input of milk during fasting periods. Therefore, some of these processors prefer to continue buying milk during fasting, even if that means that milk has to be thrown away.

Table 4-4: Effect of the presence of a long fasting season in the last month on processed volumes as well as sales volumes of liquid and processed milk one month prior to the interview

	Total sales volumes last month		
	Liquid milk (L)	Butter (kg)	Cheese (kg)
	SURE		
Fasting past month (0/1)	-48.33* (25.26)	0.58 (0.36)	3.92 (3.47)
Controls	Yes	Yes	Yes
Non-fasting mean	173.35	0.70	5.37
n	855	855	855
R ²	0.77	0.24	0.26

Note: ***, ** and * represent statistical significance at a probability of less than 1%, 5%, and 10% respectively. For a complete list of controls, see Table 4-2. Cluster robust standard errors are in parentheses.

As a robustness check, we ran two double-hurdle models to assess the impact of fasting on dairy market participation and dairy sales volumes (Table 4-5). As expected, long fasting spells only impact the decision of farmers to sell milk significantly.

Table 4-5: Effect of presence of a long fasting season in the previous month on likelihood to sell dairy products (first hurdle) and total dairy product sales over the month prior to interview, conditional on dairy market participation (second hurdle)

	Liquid milk		Processed milk products	
	Likelihood to sell	Sales volume (L)	Likelihood to sell	Sales volume (kg)
Fasting past month (0/1)	-0.85*** (0.26)	1.63 (1.64)	39.13 (57.11)	4.31 (8.26)
Controls	Yes		Yes	
n	855		855	
Log likelihood	-1750.57		-1982.24	

Note: ***, ** and * represent statistical significance at a probability of less than 1%, 5%, and 10% respectively. For a complete list of controls, see Table 4-2. Cluster robust standard errors are in parentheses.

Finally, we take a closer look at the consumption volumes of liquid and processed milk at household level. If there was a long fasting event in the week prior to the interview, households' consumption decreases, but not significantly (Table 4-6). We further observe no effect in the consumption of processed milk products. The limited impact of fasting on weekly consumption of milk could indicate that the Orthodox adult household members – which represent a large majority in our sample since 85% of the producing households indicates to be Orthodox Christian – compensate the forgone consumption of milk (and other ASFs) during non-fasting days (which is possible given the construction of our fasting indicator²³). Alternatively, it is also possible that we observe only a small effect of a few fasting days a week, simply because the intake of milk by adult members is limited anyway. We find evidence that supports both arguments (a detailed analysis can be found in Supplementary material B.4), yet it seems most likely that adult members in producing households consume little milk anyway as milk is mainly intended for young children in Ethiopia. Furthermore, we observe that households' milk consumption during long fasting episodes would be even lower, were it not for the fact that the youngest children are given considerably more milk. Their milk consumption increases by 40% during long fasting spells, and they consume on average about 0.80

²³ The fasting indicator we constructed equalled one if there were at least four fasting days in the week prior to the interview. This implies that for some households who are labelled as being interviewed during a long fasting week, there are still some non-fasting days part of that 'long fasting week' (i.e. one, two or three).

litre of milk more²⁴ (Table 4-6). This confirms the predicted effect from the conceptual model in Section 2.

Table 4-6: Effect of the presence of a long fasting period (more than four days) in the last week on consumption of liquid and processed milk one week prior to the interview

	Consumption volumes past week				
	Liquid milk household (L)	Butter household (L eq.)	Cheese household (L eq.)	Buttermilk household (L)	Liquid milk youngest child (L)
	SURE				OLS
Fasting past week (0/1)	-0.81 (0.54)	-0.49 (0.57)	-0.58 (0.49)	-0.15 (0.28)	0.77** (0.36)
Controls	Yes	Yes	Yes	Yes	Yes
Child controls	No	No	No	No	Yes
Non-fasting mean	3.77	2.18	1.41	1.34	1.90
n	848	849	841	847	297
R ²	0.15	0.07	0.09	0.26	0.17

Note: ***, ** and * represent statistical significance at a probability of less than 1%, 5%, and 10% respectively. Household amounts are expressed per adult equivalent to account for household size and composition. For a complete list of controls, see Table 4-2. Cluster robust standard errors are in parentheses.

One of the strategies that households have developed to overcome long Orthodox fasting periods, is thus to allocate part of the excess milk to their young children, who by default are exempt from fasting participation. These findings contradict those reported by Kim et al. [306], who observed that, only 18% of the children consumed milk during Lent while 66% of the households reported to own dairy cows. There is some evidence that the farmers in our sample have more liberal attitudes when it comes to the fasting participation of children (see Supplementary material B.3). Yet, another important reason for the increased consumption of milk by children is that fasting increases excess milk in these milk producing households due to reduced market opportunities for liquid milk, since the producers we interviewed mainly produced milk for the market. Marketing opportunities for liquid

²⁴ We showed in Supplementary material B.3 that fasting participation among Orthodox producing households is far from homogenous. We wondered how this varying strictness in fasting adherence affects a household's intake of liquid milk and processed milk. As expected, we observe a larger negative impact of household's intake of both liquid milk and processed milk, the stricter a household adheres to Orthodox fasting events. Children's intake on the other hand is not affected. A detailed analysis can be found in Supplementary material B.5. Moreover, in another module of the survey, respondents were also asked to recall and report the household's intake of milk, cheese, and butter (all sourced from own production) in the middle of the latest long fasting period during which they had (at least) one cow in milk, with consumption two weeks after this fasting period. The same assessment was asked for the youngest child's milk intake. The results can be found in Supplementary material B.6.

milk drop significantly during fasting (Table 4-3) with buyers purchasing less or no milk during these periods. This increases transaction costs dramatically if farmers would still want to search for alternative buyers to sell their milk to. Since market prices of milk do not increase during fasting, it is more interesting for farmers to channel part of the non-sold milk to their children. It seems that mostly children are the ones consuming milk during long fasting seasons. Of course, there is a limit to how much milk young children can consume. In our data, there appears to be an upper limit of about 7 L per week for the youngest child. This implies that even during long fasting periods, allocating more milk to children can only partly solve the excess milk supply problem.

4.2.2. Heterogeneity in producer adaptation strategies

We further assess heterogeneity of adaptation strategies with respect to remoteness. When comparing the production and output use adaptation strategies of remote and non-remote households (Table 4-7), we find that remote households have predominantly adapted to a culture of fasting by considerably reducing their milk production at the farm, with total milk output falling by 60% during long fasting seasons. A smaller share of the produced milk is sold (p value is 0.061), while more produced milk is being processed (p value is 0.068). Non-remote households on the other hand seem to have better access to buyers who continue purchasing liquid milk during fasting, which enables them to maintain their milk production. However, we also observe a slightly negative, yet not significant, trend in total milk production in these households. The average share of produced milk being sold decreases significantly in these households, mostly caused by non-remote farmers who stop selling milk during long fasting periods. As a result, both remote and non-remote households rely significantly more on processing to overcome Orthodox fasting events. The share of produced milk being consumed is not significantly affected by the presence of a long fasting season, but if anything, it seems that non-remote households allocate slightly more milk to own consumption.

Table 4-7: Heterogeneity in total milk production at the farm and output use of produced milk by remoteness to Addis Ababa

	Milk production at the farm and output use of produced milk last month							
	Milk production (L/day)		Milk sold (%)		Milk processed (%)		Milk consumed (%)	
	<i>Remote</i>	<i>Not remote</i>	<i>Remote</i>	<i>Not remote</i>	<i>Remote</i>	<i>Not remote</i>	<i>Remote</i>	<i>Not remote</i>
Fasting past month (0/1)	-1.39** (0.63)	-1.51 (1.40)	-8.63* (4.60)	-23.44*** (5.62)	9.08* (4.50)	20.78*** (4.85)	-0.45 (2.85)	3.08 (1.98)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Non-fasting mean	2.32	10.42	13.93	59.56	63.30	26.06	22.26	13.88
n	427	428	427	428	427	428	427	428
R ²	0.39	0.77	0.31	0.55	0.20	0.46	0.10	0.22

Note: ***, ** and * represent statistical significance at a probability of less than 1%, 5%, and 10% respectively. Remote / Not remote = Below / Above median travel time to Addis Ababa (1.54 hours). For a complete list of controls, see Table 4-2. Remoteness is not included as control variables. Cluster robust standard errors are in parentheses.

Regarding sales volumes, we find that remote households sell significantly smaller quantities of milk during long fasting seasons, and volumes go down by three-quarters on average (Table 4-8). For non-remote households, we observe that the considerable heterogeneity in the ability to sell milk during fasting seasons is reflected in the total sales volumes of these farmers and overall it seems that liquid milk sales volumes tend to go down slightly, but not significant. Re-running a double-hurdle model for these non-remote households shows that fasting significantly affects the decision to sell milk, yet not the milk sales quantities when households are selling milk. For neither remote nor non-remote households, sales volumes of processed milk seem to increase during long fasting spells, but for non-remote households they seem to go up slightly.

Table 4-8: Heterogeneity in sales volumes by remoteness to Addis Ababa

	Total sales volumes last month			
	Liquid milk (L)		Processed milk (kg)	
	Remote	Not remote	Remote	Not remote
Fasting past month (0/1)	-34.05** (15.96)	-35.67 (33.99)	3.10 (4.03)	3.18 (2.72)
Controls	Yes	Yes	Yes	Yes
Non-fasting mean	46.12	265.14	7.41	5.10
n	427	428	427	428
R ²	0.29	0.86	0.60	0.20

Note: ***, ** and * represent statistical significance at a probability of less than 1%, 5%, and 10% respectively. Remote / Not remote = Below / Above median travel time to Addis Ababa (1.54 hours). For a complete list of controls, see Table 4-2. Remoteness is not included as control variables. Cluster robust standard errors are in parentheses.

Regarding consumption volumes (Table 4-9), remote households significantly reduce the amount of liquid and processed milk consumed – by 43% and 53% on average respectively. Consumption volumes of liquid and processed milk in non-remote households on the other hand are barely affected by fasting periods. Yet, both types of households allocate more milk to children during fasting, and significantly so among non-remote households. Since we found that remote households cut down their milk production significantly during long fasting seasons (Table 4-7), we find that children's milk intake does not increase significantly during fasting. As stated in the introduction, the households sampled in the survey mainly produce for the market while surplus milk is used for own consumption. Therefore, if market opportunities dwindle during fasting seasons, and especially so for remote households, this makes farmers decide to reduce their milk production at the farm. Non-remote households on the other hand seem to be better connected with buyers that continue buying milk during fasting periods which allows them to maintain their milk production levels more or less during fasting periods, but they also compensate for some forgone market opportunities during fasting by channelling significantly more milk to their youngest children.

Table 4-9: Heterogeneity in consumption volumes by remoteness to Addis Ababa

	Consumption volumes last week					
	Liquid milk household (L)		Processed milk household (L eq.)		Liquid milk child (L)	
	<i>Remote</i>	<i>Not remote</i>	<i>Remote</i>	<i>Not remote</i>	<i>Remote</i>	<i>Not remote</i>
Fasting past week (0/1)	-1.24*** (0.45)	-0.04 (0.13)	-0.62*** (0.15)	-0.23 (0.20)	0.63 (0.91)	1.20*** (0.41)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Child controls	No	No	No	No	Yes	Yes
Non-fasting mean	2.88	4.40	1.16	0.73	1.33	2.36
n	417	419	417	419	134	141
R ²	0.20	0.16	0.24	0.17	0.25	0.34

Note: ***, ** and * represent statistical significance at a probability of less than 1%, 5%, and 10% respectively. Remote / not remote = below / above median travel time to Addis Ababa (1.54 hours). For a complete list of controls, see Table 4-2. Remoteness is not included as control variable. Cluster robust standard errors are in parentheses.

4.2.3. Market prices of dairy products

Looking at the price effects linked with fasting (Figure 4-1), we find that market prices of liquid and processed milk as reported by the producing households are low during periods of abundant supply (from the summer until the end of the year) and low demand (the Advent and Lent fasting periods). Conversely, prices are at their highest level when high demand (feasts like Christmas and Easter) interacts with a declining availability of milk (in the beginning of the year). Figure 4-1 also shows that price fluctuations are most outspoken for butter and, to a lesser extent, for cheese. Milk prices seem to be barely affected by seasonality in milk supply or demand – ranging from 12 ETB/L to about 12.8 ETB/L – although milk prices are slightly lower during Lent.

The prices reported by farmers might mask larger fluctuations as the price questions included in the survey ask farmers to detail average prices over quite large time spans. Therefore, we further detail price swings by comparing market prices that farmers obtained in the midst of the latest long fasting period when they had at least one cow in milk with the price obtained two weeks after this fasting period. Also here we find that that market prices of liquid milk do not vary significantly, but seems to vary a bit more for remote households. As such we observe that mostly producing households located more than 1 to 1.25 travel hours from Addis Ababa report larger price swings for liquid milk, with price drops 6% being reported. Farmers located less than 1 hour from Addis Ababa on the other report price swings of only 2%. Price swings for butter and cheese seem not to be affected by market accessibility and drop by one-third during fasting periods on average. The reduced supply of liquid milk on the market explains why we observe only small price swings for liquid milk, predicted by the conceptual model in Section 2. The larger price swings that occur for processed milk products on the other hand can be partly explained by the increased processing of milk as well as opportunity costs that arise because of storage of processed milk products.

The price drops reported by the famers in this sample are smaller than those we found in the literature. However, the latter price drops were found through focus group discussions with a small sample of dairy farmers. Therefore, the price declines we found in literature are indicative but cannot be considered representative for the producer milk prices in the country. It is possible that the questions in the survey asking farmers to detail market prices are not sensitive enough to capture true price swings occurring in the market since farmers were asked to report prices over specified time periods and prices might peak more immediately after fasting during important religious festivities (such as Easter and Christmas). Yet, we still expect that price changes are small in the study area since farmers are aligning milk production volumes with fasting periods, produced milk is increasingly processed to more storable milk products and/or fed to young children, which all reduce the supply of liquid milk on the market.

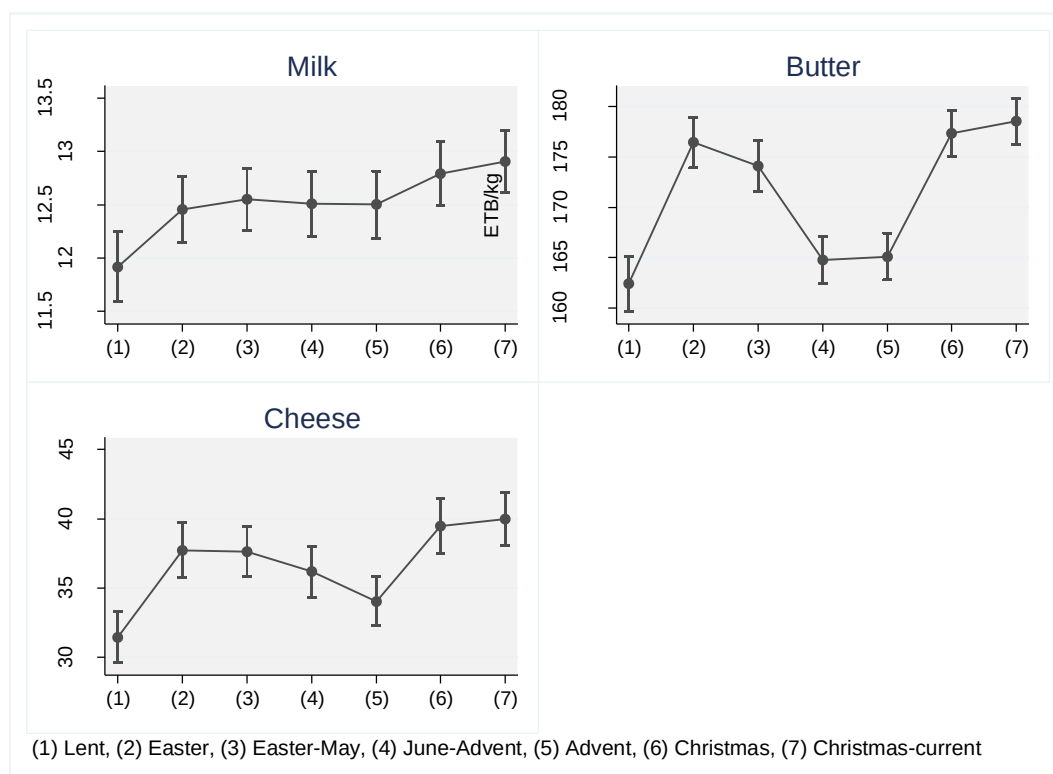


Figure 4-2: Average market prices of liquid and processed milk reported by our respondents throughout the year

Note: 1 USD = 27 ETB at the time of the survey

5. Discussion and conclusion

The impact of food taboos on food consumption and value chains is not well understood. Fasting practices embedded within the largest religious community of Ethiopia, the Orthodox Christians, create significant seasonality in milk demand. However, quantitative evidence on the implications for dairy farming households is limited. In this chapter, we detail the impact of fasting on production, marketing, and consumption decisions of producing household located in the dominantly Orthodox and commercially-oriented setting of the Great Addis milk shed. Choosing this target group allows us to measure the simultaneous impact of fasting on production, processing, and marketing decisions of milk producers as well as on milk intake (the latter one unhampered by availability constraints). No such comprehensive study has been undertaken in the Ethiopian context before.

We find that dairy farming households adopt diverse strategies to help them overcome periods of reduced milk demand and the importance of these strategies vary with market accessibility, which we proxy in this chapter by remoteness of the households to the capital Addis Ababa. We find that remote farmers mainly rely on reducing the production of milk by their dairy herd during long fasting periods. The milk that is still produced by these households is processed or channelled to their young children. As a result, these households sell significantly smaller quantities of liquid milk during fasting periods, but we observe no effect of fasting on sales volumes of processed milk. While these households consume significantly less liquid and processed milk during fasting periods, the intake of milk by their youngest children is not affected by the presence of a long fasting period. The youngest children seem to be the ones that still consume milk during fasting periods. Liquid milk sale opportunities of non-remote farmers on the other hand are significantly less affected by long fasting periods. But we observe considerable heterogeneity among these farmers in their ability to maintain milk sales during fasting seasons. Some of these farmers seemingly benefit from being better connected to buyers that continue purchasing milk during fasting periods. As a result, non-remote farmers, on average, do not reduce the total production of milk at their farms significantly. Yet, to compensate for (some) forgone market opportunities during fasting, these farmers process a significantly larger share of the produced milk during fasting and they feed significantly more milk to their young children. As opposite to remote farmers, consumption volumes of liquid and processed milk in non-remote households are not affected by long fasting seasons.

Furthermore, we observe that even if milk is available at the household level, household intake of milk remains low and that milk is mainly channelled to young children. While young children seem to benefit from long fasting seasons, their intake of milk still falls short by 1.6 and 0.8 L during non-fasting and fasting weeks respectively as food-based dietary guidelines recommend a weekly consumption of 3.5 L of milk [23]. Producing households need to trade-off between nutrition and

income generation objectives and fasting seems to impact this trade-off in favour of nutrition objectives due to the reduced opportunities for marketing liquid milk during fasting seasons.

Our findings have a number of important implications. First of all, improved nutritional knowledge could influence the trade-off producing households make between consumption and income generation objectives. Therefore, nutritional awareness creation can help to increase milk consumption by all household members outside of fasting seasons but also to increasingly allocate excess milk during fasting to those members that are officially exempt from fasting, i.e. not only children, but also pregnant/lactating women, and elderly. Increased consumption of milk by these vulnerable groups during long fasting seasons could further help to avoid the seasonal halting of milk production as well as the need for households to process milk, which is labour-intense and input-inefficient since farmers use traditional processing techniques and materials. The potential value addition that can be created is thus low [13, 236]. This also explains why farmers in this milk shed have specialized in liquid milk sales.

Second, further investments are needed to intensify milk production systems and increase milk productivity so that more milk becomes available at lower prices. As long as milk will remain a luxury product, nutritional awareness creation will not be sufficient to make producing households consume more milk, especially outside fasting periods. Lower prices of milk will make milk more accessible to household members that are currently not prioritized when it comes to milk intake. Such investments however will only be attractive to producing households if transaction costs are reduced both during as well as outside fasting and the effects of seasonal demand swings are smoothened. Inefficiencies in the milk market raise transaction costs for producers to market milk and thus reduce their profit margins. If such costs could be reduced by investing in improved market functioning, it would not only make milk cheaper for consumers, but simultaneously guarantee remunerative and stable incomes for producing households. Investing in better market functioning – not only physical facilities but also enforcement of property rights and the law of contract – could thus indirectly contribute to productivity gains.

To smoothen demand swings, interventions should focus on maintaining a rather constant demand for milk during fasting periods. At the consumer side, nutrition awareness creation could help to raise the consumption of milk by non-Orthodox households, but also of Orthodox members who are officially exempt from fasting. Studies have found that social norms might still force these groups to engage in fasting practices with negative repercussions for nutritional and health outcomes [306]. Furthermore, the establishment of school milk programmes could also help to create a guaranteed market outlet during fasting periods. Furthermore, as markets of milk are still highly fragmented in Ethiopia, improving transportation facilities could help to assure market integration and marketing of liquid and processed milk to areas where fasting is less prevalent especially for remote producing

households. Having guaranteed market outlets will incentivize these producers to maintain – rather than cutting down – their production during fasting, or better make them invest in expanding and intensifying their milk production activities.

Also public and private investments to support and expand processing facilities would help farmers to continue selling milk during fasting spells, without requiring these farmers to specialize and invest in home-processing activities which are time- and input-inefficient and do not create substantial value addition [13, 236]. This need has been recognized in the Livestock Master Plan of the Ethiopian government of 2015. Even though milk processing plants are popping up increasingly in Ethiopia, there are still too few (about 40 industrial processing plants spread over the country) and many of these plants operate below capacity. Having a higher number of fully operational small-scale and industrial-scale processing plants not only rises the demand for milk both during and outside fasting, it would simultaneously increase efficiency, productivity, and safety of the produced milk products because of their use of modern processing technologies and economies of scale. Yet, enhancing processing practices will not be sufficient, and further efforts will be needed so that the produced milk products can be properly stored during periods of slack demand and further efforts are needed to integrate markets that enable processors to maintain their sales of processed milk products during fasting periods.

Our findings point to new areas for further research. First, our sample is not representative of the population at large, since we only sampled milk producing households within the Great Addis milk shed. This sample should be expanded to include milk producing households in other regions and milk sheds. Since the milk shed of Great Addis is the most commercially developed milk shed in the country, with more market opportunities for farmers to sell their milk, one would expect to observe potentially larger effects of fasting on production and output use decisions in other milk sheds with possibly negative repercussions on the milk intake of children among these producing households.

Second, further research should collect repeated observations over time and focus on a cohort of producing households before, during, and after fasting. We used cross-sectional data where the households sampled during and outside of a long fasting season are not identical. We control for household and individual characteristics so as to make both groups interviewed during and outside a long fasting period as comparable as possible and therefore reduce the probability of having biased fasting estimates. Yet, to check the robustness of our findings, it is advised to re-run the analyses with panel data that capture producing households' behaviour both during and outside fasting. Furthermore, repeated observations over time will allow to further assess the differential impact that might be present for different fasting periods (additional analyses in Supplementary material B.6 seem to hint in that direction but are based on recall data of the households and can therefore be subjected to biases). Moreover, further research could benefit from using diaries instead of recall

data so as to more accurately assess the impact of fasting on milk production, milk output use, dairy sales and consumption volumes.

Third, future research would benefit from more focus on quantifying the nutritional and health impacts of fasting adherence by children but also by other vulnerable population groups (pregnant/lactating women, elderly) who are officially exempt from fasting. Having such evidence can help to give more weight to the importance of awareness creation and improve information dissemination on the potential adverse nutritional and health effects of fasting.

Fourth, only liquid and processed milk have been looked at in this study. It would be good to broaden up the study to other ASFs such as meat and eggs. Since slaughtering of animals can be more easily planned, one would expect that the impact of fasting on meat producing households is smaller (i.e. these households will wait to sell or slaughter their animals until fasting periods are over). The impact of fasting on egg producing households is also likely to be smaller compared to milk producing households given the lower perishability of eggs compared to liquid milk.

Finally, future studies, in other countries, could target different religious groups and assess how their food habits and beliefs are related to consumption and food value chains.

CHAPTER 5

Milk in the city:

Profiles and development paths for urban dairy holders in Ethiopia

This chapter is based on:

D'Haene, E., and D'Haese, M. (2019). Milk in the city: Profiles and development paths for urban producers in Ethiopia. Development Southern Africa. DOI: 10.1080/0376835X.2019.1689099.

Abstract

Demand for milk is growing fast in urban areas. Due to poorly developed rural infrastructure, urban dairy farms are pivotal in making milk available and affordable in towns and cities. Yet current supply fails to meet the increasing demand. In order to formulate fit interventions that can expand urban milk production, a detailed understanding of urban production systems is needed. Using a cluster analysis approach, we profile 304 urban dairy farms in Mekelle, Northern Ethiopia, along three dimensions: input efficiency, market integration, and resilience towards demand seasonality. Our results suggest five distinctive farm types: surviving farms, processing farms, young male entrepreneurs, established output-efficient farms, and established output-input-efficient farms. We observe large discrepancies in terms of dairy enterprise's productivity, profitability, and suitability in future urban policy planning. For each of the identified production systems, we sketch potential intervention approaches that can feed into more tailored dairy development programmes.

Keywords: Ethiopia, farm system, intervention approach, Mekelle city, milk production, typology, urban agriculture

1. Introduction

Economic progress is shifting the starchy-staple diets in the African continent towards food baskets that increasingly include nutrient-dense foods like animal-based produce. This nutritional transition occurs the fastest in urban areas [317]. Depending on the considered ASF, consumption is expected to have a three- to sevenfold increase by 2050 in SSA. Alarming, growth in local production is not keeping up with this increasing demand [318]. Particularly urban areas are at risk of food and nutrition insecurity, given the rapid urbanisation trends; the total number of African dwellers is projected to rise from 400 million in 2010 to 1.3 billion by 2050 [212]. Identifying appropriate measures to mitigate the negative impact of urbanisation on food and nutrition security is thus pivotal.

Since ASFs are highly perishable and rural infrastructure is often poorly developed, production of such products in (peri-)urban areas is thriving in many African countries [319]. Yet, agricultural activities in town and city centres are often unplanned and informal (e.g. Thornton [320]). At the same time, policy makers and development practitioners are increasingly aware of the need of steering urban milk production to safeguard supply of ASFs in urban centres [212]. Scholarly studies have identified barriers and opportunities of urban livestock production in general (e.g. Hippolyte et al. [321], Gororo and Kashangura [322], Roessler et al. [323], and Crump et al. [324]), but have insufficiently covered how these vary across different types and forms of livestock activities within cities. Urban dwellers keep livestock for different reasons and in different ways than farmers in rural areas. Additionally, there is a substantial degree of variation within the group of urban livestock keepers, as well as among those who specialize in particular livestock practices such as dairy. Establishing a comprehensive overview of such farm diversity²⁵, is essential in order to propose fit regulatory or supportive measures for policy making and programme development.

²⁵ To our knowledge, only one paper has specifically addressed peri-urban dairy diversity (i.e. Toure et al. [325]).

2. Background

Within SSA, Ethiopia hosts the largest estimated livestock herd and represents the second most populous country. Moreover, Ethiopia is among one of the fastest urbanizing countries in the world; its urban population is about to triple, from 15.2 million in 2012 to 42.3 million by 2034 [326]. Recent figures estimate the annual national milk production at 5.2 billion L of which 80% originates from milking cows [230]. Despite this large volume of cow milk produced, milk productivity remains extremely low (yearly average of 125 kg milk/cow in lowland grazing zones to about 200 kg/cow in highland mixed farming zones) [327]. Availability and access to high-quality inputs and services (such as feed, genetics, and health care), as well as poor market infrastructure and support still hamper milk production and productivity [42, 328]. Average per capita milk consumption has been estimated at around 20 L, although large variations can be found across towns and cities [201]. These low intake levels are in part due to limited supply, but can also be attributed to a variable demand. Demand seasonality of milk is high in Ethiopia because of fasting rituals that are traditionally embedded in the Orthodox Christian Church, the dominant religious community within the country. Fasting rituals make milk demand highly variable which is hard to cope with for milk producers and other actors in the dairy value chain [42, 328].

Although rural milk production is the main provider of milk in Ethiopia accounting for about 98% of the total national milk production [201], smallholder farm systems are rapidly emerging in urban and peri-urban areas and differ greatly from their rural counterparts. Rural dairy farms operate extensive low-input low-output mixed crop livestock systems, where indigenous cattle are predominantly held to provide traction power. The milk produced is mainly used for household consumption and excess milk is processed into butter and cheese. Urban dairy farming, on the other hand, consist of specialised production units often operated within the farming household's residence compound, adopting zero-grazing systems due to land scarcity. Most of the feed is purchased, and agro-industrial by-products are often supplemented to the diet. Urban producers typically own improved crossbreeds or pure grade exotic cattle, which give higher milk yields than local breeds. The bulk of produced milk is marketed to neighbours through informal channels or to FSPs (milk shops, cafés, restaurants, and hotels) [201, 245, 329].

3. Materials and methods

3.1. Data

A cross-sectional study was conducted in the seven sub-cities of Mekelle city, the regional capital of the Tigray region, between January and February 2016. Urbanisation in this region is slightly higher than the country's average (16%) with one out of five living in urban areas [245]. Mekelle is the sixth largest city of the country with a population of around 247,000 people aged 10 years and above [296]. In Tigray, about 95% of the population adheres to the Orthodox Church [15], which creates a suitable context to analyse resilience of urban dairy farm systems towards demand shocks such as Orthodox fasting events.

To get a representative sample of producers for Mekelle city as a whole, we collected estimates of the number of active milk producers from the different sub-city administrations so as to get an overview of the total population of dairy producers in the city. According to these estimates about 1,400 dairy farms are (officially) active in Mekelle of which 30% operates in the sub-city Hawelti, 26% in Hadnet, 13% in Quiha, 13% Adi Haqi, 12% Ayder, 3% Semien, and 3% Kedamay Weyane (a visual representation of the different sub-cities of Mekelle can be found in Chapter 2, Figure 2-11). To obtain a margin of error of 5% and a confidence level of 95% that the actual population mean falls within the margin of error, we had to sample 302 dairy producers in total. To know how many producers needed to be sampled within each sub-city to get a total sample of 302 producers, we multiplied the shares of dairy holders in each sub-city by the total sample size. Since no detailed lists are available summarizing the details of these urban dairy producers, we had to trace producers in another way. Therefore, we adopt a pragmatic approach so as to assure we draw a random sample of dairy producing households in each sub-city. To do so, we adopted a combination of the following strategies: (1) milk producing households in Mekelle often let their manure to dry outside their homes, which we could use to trace them, (2) we asked around in the respective sub-cities, usually a causal passer-by, where we could find milk producers; (3) and after having interviewed the dairy producers, we asked them where we could find other producing households in the sub-city. Our final sample included 304 dairy farmers.

Interviews were done with the household member responsible for dairy farming (household head or spouse). No monetary incentives were given to participate in the survey. Four trained enumerators interviewed the farmers in the local language and a supervisor guided and closely monitored the data collection. An informed consent was obtained from all respondents. The semi-structured questionnaire used covered information on household characteristics, herd size and structure, farmer experience and training, labour force and labour division, milk production and marketing, feed purchase, land and credit usage, asset and service ownership, social capital, and household income

sources. The questionnaire was piloted before the actual survey took place. Only minor modifications were made after testing. The questionnaire can be found in Appendix 2.

3.2. Methodological approach and theoretical framework

Various exploratory statistical tools have been developed to gain insight in farm diversity. A popular method is typology construction that classifies farms into different clusters using multivariate techniques [330]. We used different clustering methods as it was shown that clustering algorithms may result in different grouping structures of a dataset [331]. We report the results of a two-step cluster analysis using a log-likelihood distance measure as it yielded a meaningful classification of the dairy farms with a fairly high goodness-of-fit. Moreover, this method proved to be robust when incorporating different combinations of discriminatory variables. The advantage of a two-step clustering procedure is that it efficiently handles large data sets and that it does not require to predetermine the number of clusters to be generated [332]. The algorithm assumes normality and independence of the included attributes, but remains fairly robust when these assumptions are violated [333].

A predefined set of discriminating variables was included in the cluster analysis. We deliberately focus on performance indicators²⁶ so as to help policy makers making better informed interventions to strengthen the urban dairy sector. In the context of Ethiopia, and specifically the city of Mekelle, one is particularly interested to see how farmers have adapted to fasting periods and which strategies they have developed to overcome periods of reduced milk demand. Next to resilience towards demand seasonality, it is also important to include input efficiency. We focus on feed efficiency as feed typically represents the highest production cost (about 65-70%) [335]. Furthermore, detailing feed efficiency in the context of Mekelle is especially relevant given the regular occurrence of (acute) feed shortages. Labour productivity could also have been a good indicator, yet we only have detailed data on costs for hired labour. Since we have no detailed data on time spend on the dairy farm by different household members, we can only roughly estimate the total labour costs. Finally, market integration of farmers is also crucial, so as to formulate interventions that reduce transaction costs. Reducing transaction costs will allow farmers to fetch remunerative and stable milk prices and it will simultaneously allow consumer to buy cheap(er) milk. The operationalisation of these indicators (resilience towards demand seasonality, input efficiency, and market integration) is explained below. We did not perform a factor analysis to reduce the number of explanatory variables in the cluster analysis as the attributes we included are not highly correlated (absolute values were below 0.6). The included indicators allow us to gain insight in the productivity and profitability of urban dairy enterprises as well as their suitability in future urban policy planning.

²⁶ We did not focus on internal factors such as e.g. resources owned, management skills, experience in farming, or time spent earning off-farm income, since internal factors have been shown to affect farm performance and therefore represent a more indirect way of measuring farm performance [334].

As mentioned above, Orthodox fasting has a decisive impact on the dairy farm system in the study region. Fasting greatly affects milk prices and marketability leaving the farmers with few options during fasting: selling milk at reduced prices (that might not always cover production costs), processing milk to increase its shelf life, aligning the number of milking cows to the occurrence of fasting periods, consuming the milk themselves, giving it away for free or just spoiling it. In our sample, the dominant strategies adopted by producers is selling milk below production costs or processing the milk to more storable milk products²⁷. Therefore, we assess the robustness towards demand shocks resulting from Orthodox fasting, with the percentage of produced milk being sold and the percentage of produced milk being processed during fasting.

As urban dairy farm businesses are largely dependent on purchased feed, we included the milk production:feed cost ratio to gain insight into the production-economic viability of farm businesses²⁸. This variable was calculated based on the daily milk production and daily cost of purchased feed per animal (accounting for calves, heifers and milking cows). We only considered the feed purchased²⁹ and not that acquired through cut-and-carry or exchange, as their contribution was found to be negligible in the total feed uptake. High milk production:feed cost ratios signal higher input efficiencies of the dairy farms as more milk is produced per unit of feed cost.

Finally, we included two variables reflecting how well the farmers have integrated in the market, namely the minimum³⁰ producer price for liquid milk (which correspond to prices observed during fasting periods) and the milk price fluctuation experienced by farmers during fasting periods (which we proxied using the difference between the maximum (i.e. non-fasting price) and minimum milk producer price). Farmers who have made good market agreements with their milk buyers, are expected to be more likely to experience smaller price variations and higher milk prices. Moreover, having reliable market outlets encourages producers to invest more in commercial farm systems [336].

Once the clusters were identified using the discriminatory variables mentioned above, we assessed the differences between the identified farm clusters. For continuous variables, both parametric

²⁷ Average percentage of produced milk that is consumed by farming households amounts to barely 4% during Orthodox fasting. 15% of the households indicated to give away milk for free, but only 16 out of the 304 interviewed farms indicated to give away milk more 'frequently', which was on average less than 2 L of milk a week.

²⁸ We did not collect data on the dry matter intake of milking cows due to accuracy problems; as such we could not use the feed conversion rate. Farmers are more likely to accurately report feed costs, hence our choice for milk production:feed cost ratio.

²⁹ Calculations based on our collected data from the milk producers revealed that 95% of the feed fed to the cattle herd is acquainted through purchase.

³⁰ We did not include the maximum price of liquid milk because of its smaller deviation across different farms. Moreover, when including this variable in the cluster analysis instead of the minimum price, we came up with only 2 farmer clusters which showed high intracluster heterogeneity across several farm characteristics.

(ANOVA, Tukey) and non-parametric (Kruskal-Wallis, Chi-square, Mann-Whitney, Fisher's exact) tests were applied. All analyses were performed using the SPSS 22 software. Having characterised the farm clusters, we disclose development prospects for each of the identified production systems. First, we try to identify the livelihood strategies adopted by the production systems based on the framework developed by Dorward et al. [337]. We determine which farms are hanging in at subsistence level, who is able to step up and improve, and who is most likely to step out of dairy business. Using insights from the Situational Leadership Theory of Hersey and Blanchard [338] (Figure 5-1), we single out required intervention styles for each production system to enhance farm businesses and performances. This theory argues that depending on the competence (ability) and commitment (willingness) of individuals (in this case farms), a leader (policy maker or a non-governmental organisation) should adapt its leadership style and vary the degree of direction and support that is given to the recipients. As such, four distinctive leadership approaches can be defined, which vary from a very tight and top down supervision and control (directing approach) to a merely laissez-faire and bottom-up approach (delegating style). In between these two extremes lie the coaching and supporting approach, more participatory approaches with interaction between the leader and the individuals. The main difference in both styles lies in the fact that coaching requires more close supervision and direction.

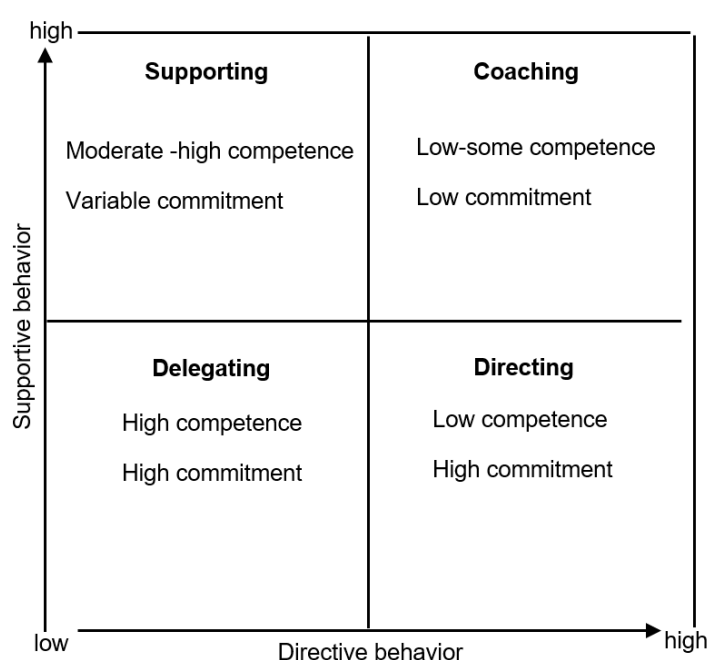


Figure 5-1: Four leadership styles as set out by the Situational Leadership Theory (elaborated from Hersey and Blanchard [338])

4. Results and discussion

4.1. Identifying and characterizing of urban milk production systems

Despite some common features and characteristics, milk production systems score differently in terms of input efficiency, fasting adaptation strategies, and market integration (Table 5-1 and Figure 5-2). The cluster analysis categorised the producers into five distinctive clusters which we qualified as follows: *processing farms* (cluster 1; 21% of the sampled farms), *surviving farms* (cluster 2; 24%), *young male entrepreneurs* (cluster 3; 13%), *established, output-efficient farms* (cluster 4; 31%) and, *established output-input-efficient farms* (cluster 5; 12%).

Overall it seems that farms in cluster 5 outperform the other production systems (Figure 5-2). Besides being thrice as input efficient compared to its peers, this farm cluster has developed proper fasting adaptation strategies, and manages to sell about 50% of their produced milk during fasting. They seem to have established good arrangements with their milk buyers and they are fairly well integrated in the market, reflected by the stable and remunerative milk price. Next in line are the producers in cluster 4 who score best in terms of market integration and linkages. Producers in this cluster face the smallest price fluctuations and receive higher milk prices than the other clusters. Furthermore, this cluster manages to sell about 70% of its produced milk during fasting periods, the highest share of all clusters. While all production systems seem to cope well with the Orthodox fasting events, producers in cluster 3 do not and they cease milk sales and do not process produced milk during fasting. This observation implies that the produced milk is largely spoiled, a big profit loss considering a total number of 166-250 fasting days a year [8, 16, 17]. Farms in cluster 1 on the other hand specialised in milk processing during Orthodox fasting and have fairly good price arrangements with its milk buyers. Finally, producers in cluster 2 are worse off as their milk prices are highly volatile and they receive far less for the milk they produce.

Table 5-1: Average values (mean $\pm$ standard error) of the discriminatory variables used in the cluster analysis for the identified farmer clusters

	Cluster 1 (n = 63)	Cluster 2 (n = 73)	Cluster 3 (n = 38)	Cluster 4 (n = 93)	Cluster 5 (n = 36)
Produced milk: feed cost ratio (ETB/L)	0.2 ^b $\pm$ 0.0	0.2 ^b $\pm$ 0.0	0.2 ^b $\pm$ 0.0	0.2 ^b $\pm$ 0.0	0.6 ^a $\pm$ 0.0
Share of produced milk being processed during fasting (%)	96.2 ^a $\pm$ 0.9	51.4 ^b $\pm$ 3.1	0.5 ^d $\pm$ 0.5	24.6 ^c $\pm$ 2.0	44.2 ^b $\pm$ 5.0
Share of produced milk being sold during fasting (%)	1.6 ^c $\pm$ 0.8	44.0 ^b $\pm$ 2.7	0.5 ^c $\pm$ 0.5	68.9 ^a $\pm$ 2.0	47.0 ^b $\pm$ 4.7
Minimum milk producer price (ETB/L)	10.1 ^{bc} $\pm$ 0.2	7.0 ^d $\pm$ 0.1	9.6 ^c $\pm$ 0.3	11.4 ^a $\pm$ 0.2	10.3 ^b $\pm$ 0.2
Milk price fluctuation (ETB/L)	3.0 ^{bc} $\pm$ 0.2	6.0 ^a $\pm$ 0.1	3.5 ^b $\pm$ 0.2	2.0 ^d $\pm$ 0.1	2.7 ^c $\pm$ 0.2

Note: ^{a-d} Means within a row with different superscripts differ significantly ($p < 0.05$).

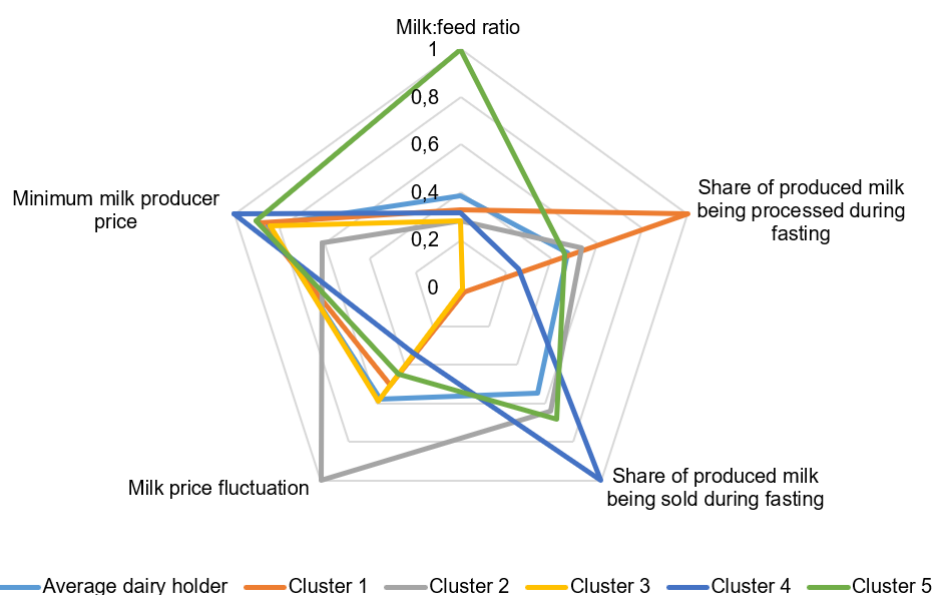


Figure 5-2: Radar chart showing how the different identified dairy holder groups score relatively in terms of each other for the discriminatory variables and compared to the dairy holder

Note: For each discriminatory variable, the relative scores were calculated by dividing the average value of each farmer group by the maximum observed value among all farmer groups

When looking into the socio-economic profiles (Table 5-2), the following patterns emerge. As such, cluster 1 is found to be characterised by a larger share of female household heads. Farming households in cluster 2 almost exclusively rely on dairying to sustain their households, whereas dairy farming, on average across the sample, contributes half to two-thirds to total household income. Households in this second cluster tend to have more illiterate or poorly schooled household heads. Cluster 3, on the other hand, is found to be dominated by young, educated, male entrepreneurs, who start up a dairy business because of lucrative reasons. Their household income per member is twice as high compared to that in the other farm clusters³¹. Finally, producers in clusters 4 and 5 share a rather similar socio-economic profile and both host households with significantly larger family sizes compared to the other production systems. But cluster 4 displays a significantly higher level of income diversification compared to all the other clusters as 4 out of 5 of their household heads is engaged in secondary and/or tertiary occupations. Moreover, clusters 4 and 5 are distinct on their social embeddedness, with producers in cluster 5 having significantly larger network sizes and higher participation rates in finance groups³².

³¹ Income data are self-reported by farmers and reflect average income in the past month. The survey was rolled out between 27/1/2016 and 12/2/2016. Therefore, income data do not cover a fasting period and should be seen as income data outside fasting periods.

³² With finance groups we refer to the informal finance groups (iqubs and idirs) that are widespread in Ethiopia. These groups are traditional ways of saving and operate completely outside the formal financial system.

Table 5-2: Socio-demographic characterization of the sampled dairy farming households and their heads

	Cluster 1 (n = 63)	Cluster 2 (n = 73)	Cluster 3 (n = 38)	Cluster 4 (n = 93)	Cluster 5 (n = 36)
Household size (number)	4.8 ^{ab} ± 0.3	4.4 ^b ± 0.3	4.1 ^b ± 0.4	5.4 ^a ± 0.2	5.2 ^{ab} ± 0.5
Household income (ETB/ member/month)	2,846.7 ^b ± 295.5	2,513.4 ^c ± 422.9	5,429.2 ^a ± 666.0	1,899.3 ^c ± 162.8	1,434.0 ^d ± 292.5
Dependency ratio ⁴	0.6 ^a ± 0.0	0.5 ^a ± 0.0	0.5 ^a ± 0.05	0.5 ^a ± 0.0	0.5 ^a ± 0.1
Share dairying income in total household income (%)	67.0 ^b ± 3.2	87.4 ^a ± 2.7	64.7 ^b ± 3.75	65.1 ^b ± 2.0	55.2 ^b ± 4.2
Household close network size ⁵ (%)					
1-2 people	3.2 ^b	53.4 ^a	0 ^b	62.0 ^a	5.6 ^b
3-4 people	3.2 ^b	17.8 ^a	0 ^b	5.4 ^b	2.8 ^b
5 or more people	93.7 ^b	21.9 ^a	100 ^b	30.4 ^a	91.7 ^b
Household participation (%)					
neighbourhood committee	19.1 ^{ab}	8.2 ^{bc}	31.6 ^a	2.2 ^c	0 ^c
religious group	7.9 ^a	5.5 ^a	2.6 ^a	11.8 ^a	13.9 ^a
finance group	85.7 ^a	16.4 ^c	100 ^a	52.7 ^b	88.9 ^a
Age distribution head (%)					
18-39	34.9 ^{ab}	30.1 ^{bc}	50.0 ^a	18.3 ^c	16.7 ^{bc}
40-59	54.0 ^a	45.2 ^a	44.7 ^a	60.2 ^a	47.2 ^a
60 and above	11.1 ^{bc}	24.7 ^a	5.3 ^{cd}	21.5 ^{ab}	36.1 ^a
Female head (%)	28.6 ^a	19.2 ^{ab}	10.5 ^b	15.1 ^b	5.6 ^b
Marital status head (%)					
married	62.9 ^{bc}	61.6 ^b	52.6 ^b	78.5 ^a	80.6 ^{ac}
single	8.1 ^{bc}	20.6 ^a	21.1 ^{ab}	5.4 ^c	8.3 ^{abc}
Divorced/separated/widow	29.0 ^a	17.8 ^a	26.3 ^a	16.1 ^a	11.1 ^a
Educational background head (%)					
no schooling	19.1 ^b	36.1 ^a	13.2 ^b	28.0 ^{ab}	13.9 ^b
informal education	11.1 ^a	12.5 ^a	7.9 ^a	11.8 ^a	25.0 ^a
junior primary	14.3 ^a	16.7 ^a	18.4 ^a	15.1 ^a	30.6 ^a
senior primary	42.9 ^a	12.5 ^b	39.5 ^a	18.3 ^b	13.9 ^b
general secondary	4.8 ^a	9.7 ^a	18.4 ^a	18.3 ^a	11.1 ^a
preparatory secondary	4.8 ^a	2.8 ^a	0 ^a	4.3 ^a	2.8 ^a
higher education	3.2 ^a	9.7 ^a	2.6 ^a	4.3 ^a	2.8 ^a
Secondary/tertiary occupation head (%)	61.9 ^b	23.3 ^c	60.5 ^b	79.6 ^a	36.1 ^c

Note: mean ± standard error for the continuous variables and frequencies for the categorical variables.

^{a-d} Means and frequencies within a row with different superscripts differ significantly ($p < 0.05$).

⁴ Dependency ratio was calculated by dividing the number of non-working household members by the total household size.

⁵ Close network size of a household was measured by asking how many people are willing to assist the household when facing difficult time periods (such as death of household head) (see Grootaert et al. [339]).

A comparison across the clusters on selected characteristics of the dairy farm system is given in Table 5-3. Overall, urban dairy farms are quite young enterprises with limited prior knowledge underscored by the observation that few households keep milking cows because of family tradition and have on average only 1 or 2 relatives that are also engaged in milk production. Clusters 4 and 5 share that they host the most experienced farm households. These producers have been operating the dairy business for 10 years, roughly 3 years more than average producers in the other production systems. Most farms indicate the generation of cash income as the most important reason for keeping milking cows, while a significant fraction of farms in cluster 5 motivate their business as an investment opportunity. Herd sizes are relatively small (attributed by the farmers interviewed to obvious land scarcity), about 2-5 heads, although producers in clusters 4 and 5 own one head more on average. All households predominantly keep crossbreeds, although the more experienced farm clusters 4 and 5 might occasionally have a cow from indigenous breed in their farming compound. Producers in clusters 4 and 5 tend to run their business together with their partner, whereas a larger proportion of single owners is found in the other clusters.

Regarding the network, we clearly see that only farms in cluster 3 know little other dairy farming households. But, producers in this cluster as well as those in cluster 1 have a wide network of feed sellers and milk buyers, whereas an opposite trend is observed for those in clusters 2, 4, and 5. Livestock extension services, artificial insemination, and trading dairy animals is common practice among urban farms, although farms in cluster 4 are significantly less involved in the latter two activities. Labourers are hired by around one-third of the farms across all clusters. These labourers are mainly young boys that take care of the daily feeding, milking, and cleaning tasks.

Table 5-3: Characterization of the dairy farm systems

	Cluster 1 (n = 63)	Cluster 2 (n = 73)	Cluster 3 (n = 38)	Cluster 4 (n = 93)	Cluster 5 (n = 36)
Engagement in dairy farming (years)	7.3 ^b ± 0.7	7.9 ^b ± 0.7	6.7 ^b ± 0.8	9.6 ^a ± 0.6	9.7 ^{ab} ± 1.2
Dairy herd size (number)	3.5 ^c ± 0.2	4.5 ^{abc} ± 0.4	3.9 ^{bc} ± 0.4	4.8 ^{ab} ± 0.4	5.4 ^a ± 0.6
Share of local breeds (%)	0 ^{bc}	0 ^c	0 ^{abc}	2.3 ^{ab} ± 1.1	2.5 ^a ± 1.4
Main motivation for farm (%)					
cash income	67.2 ^b	86.3 ^a	97.4 ^a	60.2 ^b	36.1 ^c
investment opportunity	18.0 ^b	6.9 ^c	0 ^c	23.7 ^b	41.7 ^a
saving opportunity	4.9 ^a	0 ^a	2.6 ^a	3.2 ^a	11.1 ^a
family tradition	9.8 ^a	6.9 ^a	0 ^a	11.8 ^a	11.1 ^a
Household heads being sole owner of farm (%)	38.1 ^a	38.4 ^a	47.4 ^a	21.5 ^b	16.7 ^b
Relatives in dairy farming (number)	1.2 ^a ± 0.2	2.1 ^a ± 0.4	1.0 ^a ± 0.2	1.3 ^a ± 0.2	1.5 ^a ± 0.2
Fellow dairy farmers known personally (number)	7.3 ^c ± 1.7	13.7 ^a ± 1.3	1.6 ^d ± 0.6	7.6 ^b ± 0.5	12.6 ^a ± 1.8
Feed sellers known personally (number)	7.4 ^a ± 0.5	4.1 ^b ± 0.3	8.3 ^a ± 0.4	3.6 ^b ± 0.2	3.4 ^b ± 0.3
Dairy buyers known personally (number)	11.3 ^a ± 1.1	5.1 ^b ± 0.8	12.8 ^a ± 1.0	3.2 ^c ± 0.2	2.4 ^c ± 0.4
Selling and purchasing dairy animals (%)	100 ^a	94.5 ^a	100 ^a	49.5 ^b	94.4 ^a
Artificial insemination (%)	85.7 ^{bc}	94.5 ^{ab}	94.7 ^{ab}	78.5 ^c	100 ^a
Livestock extension services (%)	81.0 ^c	97.3 ^a	81.6 ^c	94.6 ^{ab}	86.1 ^{bc}
Hired labour (%)	30.2 ^a	42.5 ^a	34.2 ^a	38.7 ^a	27.8 ^a
Dairy farm costs (ETB/animal/month)					
animal health	105.5 ^a ± 16.3	91.4 ^a ± 12.4	87.7 ^a ± 15.7	103.4 ^a ± 17.7	56.8 ^a ± 11.7
hired labor ³	155.5 ^{ab} ± 16.2	121.5 ^{bc} ± 15.7	232.9 ^a ± 34.3	118.5 ^c ± 13.6	98.6 ^c ± 10.1
feed	1,396.0 ^a ± 147.9	923.4 ^b ± 44.7	1,504.3 ^a ± 128.4	844.3 ^b ± 42.2	263.7 ^c ± 31.1

Note: mean ± standard error for the continuous variables and frequencies for the categorical variables.

^{a-d} Means and frequencies within a row with different superscripts differ significantly ($p < 0.05$).

³ This cost is only for those farms that use hired labour.

4.2. Differences between urban milk production systems

In this paragraph, we provide insights into why certain farm clusters perform better in terms of input efficiency, resilience towards demand shocks, and strength of market linkages.

The high feed efficiency of producers in cluster 5 seems to be mainly explained by their low feed costs as compared to the other cluster, while their cow milk productivity is found to be lower than that of cluster 1 and 3 (Figure 5-3). Yet, for the feed expenses they have, they manage to have a relatively high milk production, and producers in cluster 5 spent about 4 times less on purchased feed to achieve the same milk output as those in the other clusters (Figure 5-3). This can be explained by the usage of relatively cheap feed resources in this cluster that are known to increase milk production: i.e. hay, food and vegetable leftovers, as well as common salt.

First, as compared to the other clusters, farms in cluster 5 predominantly give a basal diet of hay to their herd (Table 5-4). The other farm clusters mainly give crop residues (from e.g. cereals, pulses and oilseeds), and hay is used to a lesser extent and often operates to replace crop residues³³. Crop residues are known to be poorly digestible and protein-deficient, which in turn limits milk productivity, while hay has slightly higher crude protein levels [340]. Furthermore, farmers in cluster 5 pay lower prices for the hay (80-100 ETB/donkey; see Supplementary material Table S5-1) they purchase as compared to crop residues (225-260 ETB/donkey; see Supplementary material Table S5-2).

Second, farms in cluster 5 offer more diverse diets, including 4 to 5 feed types on average. Leftovers from food or vegetables and salt, both cheap feed sources, are increasingly included by this cluster to supplement the diet next to wheat bran and *atella*. Diets in other clusters. The usage of leftovers as non-conventional feed resource reduces feed costs for cluster 5, but simultaneously enriches animals' diets [341]. The supplementation of sodium, on the other hand, tackles the subclinical sodium deficiency, that dairy animals are often faced with which hampers milk production [342, 343].

Finally, farms in cluster 5 report more often to feed prepared feed mixtures, which generally is the most expensive part of the diet and thus might contradict the low feed costs reported by this cluster (Figure 5-3). This latest figure should be interpreted with caution given the size of this cluster (36 farms). 7 out of these 36 farms report to give prepared feed mixtures to their animals. Yet, these farmers, when compared to other farmers in other clusters that also buy feed mixtures, buy on average only half of the quantities bought by other clusters (170 kg roughly every month) and prices paid are also half the prices paid by other farmers purchasing feed mixtures (2.5 ETB per kg).

³³ Less than one-third of the farmers use both crop residues and hay.

Table 5-4: Feeding practices within the identified farm clusters: mean $\pm$ standard error for the continuous variables and frequencies for the categorical variables

	Cluster 1 (n = 63)	Cluster 2 (n = 73)	Cluster 3 (n = 38)	Cluster 4 (n = 93)	Cluster 5 (n = 36)
Number of feed types used	3.5 ^{cd} $\pm$ 0.2	3.9 ^c $\pm$ 0.2	3.1 ^d $\pm$ 0.2	4.3 ^b $\pm$ 0.1	4.6 ^a $\pm$ 0.2
Farmers who report to feed (%)					
green grass	1.6 ^c	16.4 ^{ab}	5.3 ^{bc}	20.4 ^a	8.3 ^{abc}
grass hay	36.5 ^d	54.8 ^c	18.4 ^d	69.9 ^b	94.4 ^a
crop residues	82.5 ^a	80.8 ^a	89.5 ^a	80.7 ^a	36.1 ^b
wheat bran	95.2 ^a	97.3 ^a	100 ^a	97.9 ^a	94.4 ^a
atella	73.0 ^b	95.9 ^a	73.7 ^b	95.7 ^a	86.1 ^{ab}
salt	33.3 ^b	30.1 ^b	18.4 ^b	31.2 ^b	77.8 ^a
prepared feed mixture	1.6 ^b	2.7 ^b	0 ^b	12.9 ^a	19.4 ^a
molasses	1.6 ^a	5.5 ^a	5.3 ^a	1.1 ^a	0 ^a
fresh cultivated forage	1.6 ^a	2.7 ^a	5.3 ^a	1.1 ^a	0 ^a
leftovers (food, vegetable)	17.5 ^b	4.1 ^c	0 ^c	14.0 ^b	44.4 ^a
Share of purchased feed in diet (%)	94.7 ^{bc} $\pm$ 1.3	97.0 ^b $\pm$ 0.9	100 ^a	93.5 ^c $\pm$ 1.1	91.2 ^c $\pm$ 2.0
Farmers reporting feed shortage problem (%)	82.5 ^{bc}	90.4 ^b	76.3 ^c	98.9 ^a	100 ^{ab}
Reported feed shortage coping strategy (%) ⁶					
destocking	55.8 ^b	24.2 ^c	31.0 ^c	71.7 ^{ab}	86.1 ^a
storage of feed	26.9 ^b	33.3 ^b	55.2 ^a	20.7 ^b	5.6 ^c
no coping strategy	5.8 ^b	34.9 ^a	0 ^b	3.3 ^b	8.3 ^b

Note: mean $\pm$ standard error for the continuous variables and frequencies for the categorical variables.

^{a-d} Means and frequencies within a row with different superscripts differ significantly ($p < 0.05$).

⁶ Percentages reported are only applicable for those farms that indicated that they faced feed shortage problems.

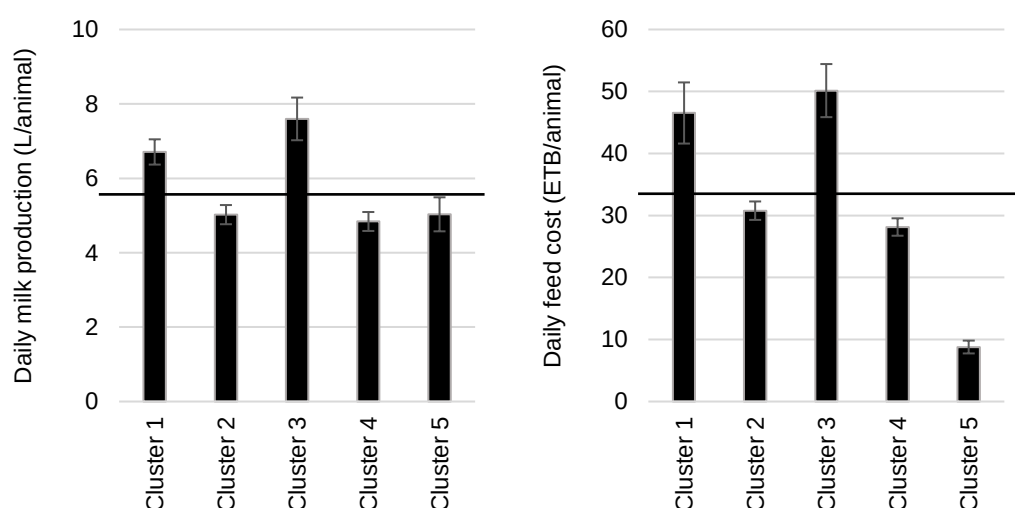


Figure 5-3: Average daily milk production and feed cost for the different identified dairy holder groups and the average dairy holder (indicated by the black line)

Not only do farmers in cluster 5 use relatively cheap feed resources, they also succeed in sourcing feed at the lowest prices. Investigating the feed market arrangements of the different clusters (of which we provide details in Supplementary material Table S5-1, S5-2, S5-3 and S5-4), reveals that overall, producers in cluster 2 experience the largest feed price fluctuations among all production systems, which confirms their vulnerable status; while farms in cluster 5 succeed in sourcing feed at the lowest prices. Moreover, producers in clusters 1, 3 and 5 consider quality as the most important contract detail in arrangements made with feed suppliers, whereas households in clusters 2 and 4 value the volume and price more. Households in clusters 1, 3 and 5 also make considerably more upfront payments for feed than those in clusters 2 and 4 who mainly pay at the time of transaction. Furthermore, producers in clusters 1, 3 and 5 purchase significantly smaller quantities of feed. These production systems seem to invest in high-quality feeds which they purchase frequently, especially so for the roughages, which are known to deteriorate quick due to improper storage and conservation [329, 344]. Moreover, producers in clusters 1 and 3 source more from rural producers and less from traders and buy *atella* more often from local breweries. Despite these differences, producers in clusters 1 and 3 seem to be less confronted with higher feed prices, hence the high feed costs they report might arise from the fact that they buy more feed per animal than do clusters 2 and 4.

Also, in terms of market integration and fasting adaptation strategies, we find clear differences between the clusters. Selling and processing milk during Orthodox fasting seem to be two opposite adaptation strategies (suggested by the negative correlation term in Table 5-5). High price fluctuations and low prices of liquid milk drive producers to process their produced milk, whereas an opposite trend is observed for liquid milk marketing. Traditional milk processing is a rather labour-intensive and time-consuming activity. Studies by LIVES have revealed that in order to produce 1 kilogram of butter, on average 15.5 L of milk is needed (Hoekstra, 2014). Butter producer prices in our sample vary between 160-200 ETB/kg. Liquid milk prices on the other hand fluctuate between 10-13 ETB/L. The value addition achieved by processing is thus almost negligible, which might explain why producers barely process milk during non-fasting periods (Table 5-6). Except during Orthodox fasting, when milk demand drops significantly, processing of milk into butter might be interesting for urban producers as it increases the shelf life of the produced milk so as to bridge the fasting period. As such, we observe that during fasting all milk production systems, except for cluster 3, process at least half of their milk production. Yet the processed milk is only marketed by households within clusters 1 and 2, who sell (excess) butter to neighbours³⁴. Also, for butter, producers in cluster 2 receive lower prices and experience bigger price fluctuations as compared to cluster 1 (Supplementary material Table S5-5).

³⁴ In our sample of 304 urban farms, only 4 farms sell other dairy produce besides butter (e.g. cheese, yoghurt or buttermilk). Moreover, only 12 farms had other buyers than neighbours (e.g. trader or FSP).

Table 5-5: Correlation matrix of marketing variables and fasting adaptation strategies

Variable	1	2	3	4	5
1. Produced milk being sold during fasting (%)	1				
2. Produced milk being processed during fasting (%)	-0.54**	1			
3. Size of milk price fluctuation (ETB)	-0.14*	0.14*	1		
4. Minimum liquid milk price (ETB/L)	0.16**	-0.13*	-0.90**	1	
5. Maximum liquid milk price (ETB/L)	0.07	-0.03	0.01	0.44*	1

* Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).

Studying the liquid milk arrangements reported by the producers across the clusters, reveals that more producers within clusters 4 and 5 sell their milk to different types of buyers, i.e. neighbours, cafés or traders (Table 5-6). Producers included in these two clusters market their milk relatively more to neighbours compared to other farm clusters, which might explain the better price arrangements they get. Moreover, the payment frequencies they report are less frequent (i.e. weekly or less than weekly), which might suggest that they have closer relationships with their milk buyers as delayed payment is often based on trust. Households in cluster 3 on the other hand sell about 80% of their produced milk to FSPs, which partially explains their higher frequency of written arrangements. These milk buyers source significantly less milk during Orthodox fasting, which forces the entrepreneurs within cluster 3 to spoil most of the milk they produce during fasting. Again, we observe that producers in clusters 1, 3 and 5 pay much more attention to milk quality than those in clusters 2 and 4, as was the case for feed as well.

Table 5-6: Milk use and marketing strategies among the identified farm clusters

	Cluster 1 (n = 63)	Cluster 2 (n = 73)	Cluster 3 (n = 38)	Cluster 4 (n = 93)	Cluster 5 (n = 36)
Produced milk being consumed during non-fasting (%)	5.1 ^a ± 0.8	2.4 ^{bc} ± 0.6	1.9 ^c ± 0.9	2.8 ^b ± 0.5	6.0 ^a ± 1.6
Produced milk being consumed during fasting (%)	0.5 ^c ± 0.4	2.7 ^b ± 1.0	3.4 ^c ± 2.7	7.0 ^a ± 1.0	4.9 ^b ± 1.7
Produced milk being processed during non-fasting (%)	3.3 ^a ± 1.7	0.4 ^a ± 0.3	0.1 ^a ± 0.1	0.3 ^a ± 0.3	1.1 ^a ± 1.1
Producers processing milk (%)	100 ^a	98.6 ^a	5.3 ^c	73.1 ^b	80.6 ^b
Producers selling butter (%)	76.2 ^a	69.9 ^a	2.6 ^b	8.6 ^b	11.1 ^b
Milk buyer (%)					
neighbours	39.7 ^b	34.3 ^b	23.7 ^b	62.4 ^a	44.4 ^{ab}
FSPs	50.8 ^{bc}	63.0 ^{ab}	79.0 ^a	54.8 ^{bc}	41.7 ^c
traders	7.9 ^{bc}	15.1 ^b	0 ^c	11.8 ^b	36.1 ^a
Farmers who have more than 1 type of milk buyer (%)	4.8 ^c	15.1 ^b	2.6 ^c	33.3 ^a	22.2 ^{ab}
Arrangement for milk (%)					
written	3.2 ^b	2.7 ^b	23.7 ^a	3.2 ^b	0 ^b
about milk volume	12.7 ^c	58.9 ^b	2.6 ^c	74.2 ^a	5.6 ^c
about milk price	7.9 ^b	82.2 ^a	5.3 ^b	72.0 ^a	13.9 ^b
about milk quality	82.5 ^{ab}	50.7 ^c	94.7 ^a	21.5 ^d	77.8 ^b
Payment frequency for milk (%)					
upfront	20.6 ^a	0 ^b	2.6 ^b	0 ^b	0 ^b
daily	38.1 ^b	19.2 ^c	60.5 ^a	18.3 ^c	44.4 ^{ab}
weekly	22.2 ^b	61.6 ^a	5.3 ^c	25.8 ^b	30.6 ^b
less than weekly	20.6 ^c	23.3 ^c	34.2 ^{bc}	65.6 ^a	41.7 ^b

Note: mean ± standard error for the continuous variables and frequencies for the categorical variables.

^{a-d} Means and frequencies within a row with different superscripts differ significantly (p < 0.05).

Table 5-7: Short summary of the identified urban milk production systems

Cluster	Cluster name	Input efficiency and market integration	Main characteristics
1	Processing farms	Low milk:feed ratio Medium-strong market integration	Specialized in milk processing, especially during fasting periods Attention for milk and feed quality Extended feed supplier network
2	Surviving farms	Low milk:feed ratio Weak market integration	Dairy is main or only income generating activity Illiterate or poorly educated household heads Adverse and volatile milk and feed prices
3	Educated male entrepreneurs	Low milk:feed ratio Medium market integration	Educated, young, male entrepreneurs Dairy as a lucrative business Attention for milk and feed quality Extended feed supplier network Main milk buyers are FSPs
4	Established output-efficient farms	Low milk:feed ratio Strong market integration	Long dairy experience Large herd size Dairy as a side business Extended milk buyer network
5	Established output-input-efficient farms	High milk:feed ratio Strong market integration	Long dairy experience Large herd size Attention for milk and feed quality More diversified dairy diets (inclusion of leftovers and common salt) and hay as main basal feed Extended milk buyer network

4.3. Development prospects of the identified urban milk production systems

Having characterised the farm clusters, this section aims at gaining insight in the development prospects of the identified urban production systems and elicits required interventions for each production system by using the livelihood strategies framework developed by Dorward et al. [337], combined with the Situational Leadership Theory of Hersey and Blanchard [338] (Figure 5-4). We show that people who engage in urban dairy production aspire divergent livelihood strategies (from a merely survival strategy towards purely commercial interest). This results in large discrepancies among urban dairy enterprises in terms of productivity, profitability and their suitability in future urban policy planning.

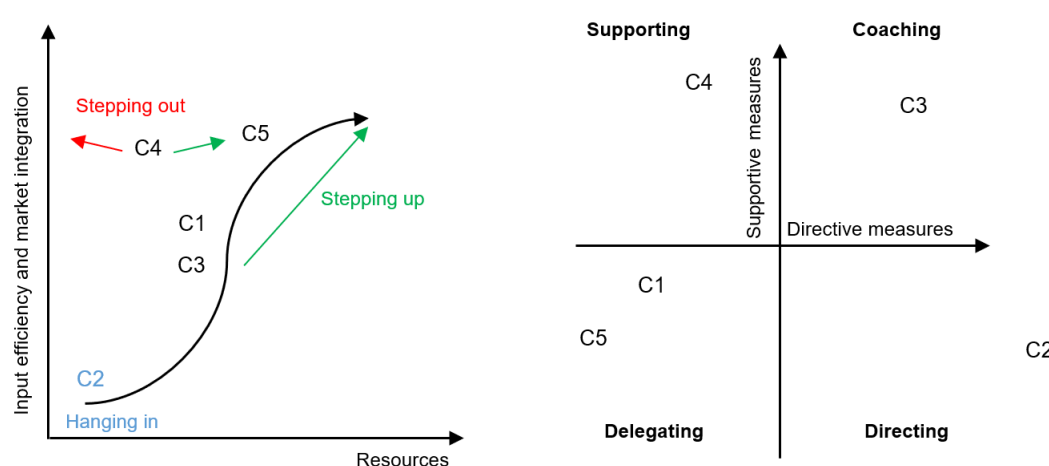


Figure 5-4: Livelihood strategies (left) and required intervention styles (right) for the different identified farm groups

A quarter of the farms we interviewed was trapped into subsistence dairy activities, facing low returns on their investments. These farms, which we termed the *surviving farms*, are hanging in, and are trapped in a low productivity and efficiency cycle as they lack resources to invest [345]. This cluster of producers lacks knowhow and is incapable of achieving good dairy cow performances albeit these producers are definitely willing and persistent to engage in dairy production as it constitutes their major or only source of household income. Improving their farm performance would require directing interventions, in which the producers are closely and extensively followed up and told what to do and how, when and where to do it, and therefore this cluster might not be a priority subgroup from an intervention programme perspective.

Farms in clusters 1 and 3, *processing farms* and *educated male entrepreneurs* respectively, on the other hand are capable and willing to intensify their dairy businesses, and step up, although farms in cluster 3 want it only partially suggested by the fact that they have not developed proper adaptation mechanisms for Orthodox fasting periods. Therefore, this cluster requires a more directive intervention approach compared to cluster 1 and should specifically be coached to help them

develop proper market channels during Orthodox fasting. A potential strategy could be to link this production system to (formal) processing facilities and hence outsource dairy processing. These farms show interest in more formal arrangements suggested by their close cooperation with FSPs. Both farm clusters 1 and 3 seem to be most promising for development programmes. They have fairly good input and output market arrangements, in which specific attention is paid to feed and milk quality, an ever-increasing issue for both consumers and producers³⁵. Producers in cluster 3 have the potential to pave the way towards a more formal operation of the dairy value chain, given their interest of in commercial dairy farming. Farms in cluster 1 on the other hand could be particularly interesting given their specialisation in small-scale milk processing, a traditional task assigned to women. Ensuring women's inclusion in scaling up and intensification of dairy production will be crucial to develop a gender-sensitive dairy sector, a key target for the Ethiopian government [199]. It has been shown that urban agriculture empowers women thereby creating positive societal spill-over effects [346]. Training and technology provision on milk processing might be the entry point in this farm cluster.

Farms in cluster 4, the *established output-efficient farms*, are a particular cluster. Even though these farms receive the highest milk prices, experience significantly smaller price fluctuations and are still able to sell a large part of their milk during fasting, their input efficiency is rather low. These farms have two options: either they will step out of dairy farming or they will step up. In the former scenario, these farms keep dairy animals primarily to accumulate resources which will allow them to move into other activities that generate higher or more stable returns [345]. If these farms want to step up, they need supporting interventions such as training on good feeding practices to help them improve their milk:feed ratio and information provision on the importance of qualitative feed and milk. This farm cluster should be convinced about the opportunities they have to expand their farm businesses so that they might shift their focus towards dairy farming as the majority of their household heads are involved in secondary and/or tertiary occupations predominantly in the non-farm sector (e.g. trade, construction, transport).

Finally, of all milk production systems, producers in cluster 5, the *established output-input-efficient farms*, seem to perform best on all three dimensions simultaneously – i.e. input efficiency, market integration and resilience towards demand seasonality. Therefore, these farmers seem to pave the way for other producers. They need little directive intervention, although they could still use supportive measures to raise their milk productivity so as to further improve their feed efficiency. Moreover, these farmers would benefit from interventions that strengthen their market integration so that they are able to sell larger quantities of liquid milk during fasting periods.

³⁵ The Livestock Master Plan launched by the Ethiopian government in 2015 pays specific attention to quality improvement both in the input and output livestock markets, see Shapiro et al. [266].

5. Conclusion

Our empirical research profiled 304 urban producers in Mekelle, Northern Ethiopia, along three dimensions: input efficiency, market integration, and resilience towards demand seasonality. Based on these data, farms were classified into five distinctive urban milk production systems. These are (1) *surviving farms*, (2) *processing farms*, (3) *young male entrepreneurs*, (4) *established output-efficient farms*, and (5) *established output-input-efficient farms*. Thus, on one extreme are *surviving farms* who are trapped into subsistence dairy activities, facing low returns on their investments. On the other extreme of the productivity spectrum, a small cluster of *established output-input-efficient farms* are found to be highly input efficient, well integrated into the dairy market and fairly resilient towards demand shocks, needing only small nudges to further enhance their farm operations. In between, there are three clusters of farms that all cope with a low input efficiency and could use supportive measures to strengthen their market integration and resilience towards demand shocks. For each of the identified farm types, we sketch potential intervention methods which account for competences and willingness of the targeted production systems. While clustering is a valid method to characterize the dairy farmers in our sample, one cannot readily extrapolate our findings to the whole population of dairy producers in Mekelle. Moreover, we tried to assure that the sample of dairy farmers was randomly drawn from the total population of producing households in the city of Mekelle. Yet, we cannot adequately assess whether we achieved a completely random sample given the lack of official registration and record keeping of dairy producing households in the city. Therefore, more studies are needed to validate our findings. But although the present research was case study-based, similar farm profile types may be identified in other urban localities.

CHAPTER 6

Unravelling preferences for religious ties in milk transactions: A consumer perspective

This chapter is based on:

D'Haene, E., Tur Cardona, J., Speelman, S., Schoors, K., and D'Haese, M. (2020) Unravelling preferences for religious ties in food transactions: A consumer perspective. Manuscript under revision.

Abstract

Individuals have the tendency to interact with similar others, a phenomenon that has been termed homophily. When trust is low and uncertainty is high, a common setting in developing countries, individuals might preferentially trade with members that belong to the same social group to reduce transaction costs. Such preferential transaction flows ultimately result in market coordination problems. Yet, there is arguably insufficient scholarly attention to the presence of trade breakdown across social groups and standard economic analysis has very often eschewed to incorporate group membership when modelling individual behaviour and market outcomes. We contribute at filling this void, by examining if religion impacts milk transactions in the Ethiopian value chain. Using a discrete choice experiment, we study whether milk consumers discriminate against potential milk sellers based on their religious affiliation. In the choice tasks, milk seller profiles were constructed using five relevant attributes: milk price, distance to the selling point, type of seller, gender and religious affiliation of the seller. We observe clear consumer preferences for lower milk prices, shorter distances, and milk producers over milk shops. When accounting for attribute non-attendance, our findings show that about half of the consumers take religion into account when deciding among seller profiles and preferred co-religious sellers. These consumers display clear preference for co-religious sellers, but seem not to trade it off to other important attributes such as distance and price. Our results add important nuances on the role of religion in consumer purchase behaviour and market segmentation.

Keywords: buyers, choice experiment, Ethiopia, market segmentation, milk transactions, Mekelle city, religious ties, trading preferences

1. Introduction

In the previous chapters, we have shown how religion affects milk intake, milk production and dairy farming systems, by focussing on the impact of Orthodox fasting practices. In this chapter as well as in the next chapter, we will investigate if sharing religious ties is an important determinant in people's transaction decisions, taking the specific case for milk. In this chapter we take a buyer perspective, while the next chapter focuses on the producer perspective.

The tendency of individuals to interact with similar others e.g. based on ethnicity, gender, or religion, has been termed homophily. Homophily involves some degree of discrimination towards others [347]. This differential treatment can result from intrinsic preferences for a particular group over others (taste-based discrimination; see Becker [348]) or because of information asymmetries. When person-specific information is missing, economic actors use group-level information to make inferences on an individual's characteristics, capacities and/or behaviour (statistical discrimination; see Phelps [349], Arrow [350] and Aigner and Cain [351]). Sharing the same group identity signals a same set of embedded norms and beliefs, which reduces information costs and risks, and hence increases trust and cooperation [352-354].

Discrimination can result in persistent inequalities. As such, a large body of scholarly literature has revealed that employers often discriminate against low-status or minority groups when selecting among several identical job applicants (e.g. lesbians in Germany [355], migrants in Austria [356] and the United States [357], Muslims in the United States [358], and non-upper-castes in India [359]). Similar results are found in the (rental) housing market (see e.g. Bayer et al. [360], Schwegman [361], Early et al. [362], and Schwegman (2019)). Few studies have looked at the product market (e.g. cars [363, 364], iPods [365], and baseball cards [366]) and very often these studies have turned to online platforms (e.g. eBay) for their investigation. Also here discriminatory practices against minority groups are evident. Yet, further exploration of such practices is needed, since most studies today have focused on high-income countries predominantly exploring race and ethnicity biases.

Most studies on group affiliation and its impact on behaviour can be found in social psychology literature. The importance of including group identity to study economic outcomes was only recently recognized with the work of Akerlof and Kranton [367] and so far, few studies have looked at the impact of social identity on economic transactions. If transactions predominantly occur among individuals who share the same group identity, this contributes to segmented markets which will obviously come at a transaction and welfare cost for the society [20]. Available research on consumer behaviour that has incorporated the concept of social identity has been directed to two important topics: first, the impact of a consumer's social identity on product and store choices and second, the impact of a seller's social identity on consumer choices. While the first topic on the

impact of a consumer's cultural and religious background on purchase behaviour is discussed in numerous papers, the second topic on the seller's social identity has not yet received sufficient scholarly attention. The few studies that have been performed in product markets, all report that buyers are less willing to transact with sellers from social minority groups and if they do transact they are inclined to pay less than when the product was offered by a seller of the social majority group [364-366, 368-370]. This evidences that social identity can explain why people treat others differently in economic transactions.

This chapter seeks to understand if and how religion affects the Ethiopian milk market. The Ethiopian milk market is plagued by several problems which result in considerable market inefficiencies. The existence of coordination problems that impede a proper market functioning, however, has not yet received sufficient attention. In this chapter, we take a buyer perspective and detail if religion affects consumer purchase behaviour. More specifically, we aim at answering the following two questions: (1) do consumers consider the religious affiliation of a seller when making a choice to purchase from this seller and (2) if a consumer does consider the religious affiliation of a seller, does s/he prefers sellers from the same religious group? An affirmative answer to both questions, points to (in)conscious self-selection to co-religious sellers, contributing to religious market segmentation. We focus on the specific case of Ethiopia and milk. Several reasons that enforce each other, make us hypothesize that religion might be an important factor in a consumer's (initial) selection of milk suppliers: (1) the milk market that operates predominantly informally, (2) the religious symbolism of ASFs, (3) the widespread occurrence of co-religious networks due to low levels of trust in other religious groups and the geographical dispersion of religious groups, (4) and the occurrence of informational asymmetries that require trust from consumers in milk sellers.

78% of the traded milk volume in Ethiopia is sold on the informal market [230] making it likely that religion acts as an informal coordinating mechanism in the milk value chain both in repeated and single transactions. ASFs are religiously loaded in Ethiopia not only because of religious slaughtering rituals but also and maybe more important because of the dominant Orthodox fasting practices. Many restaurants, bars, and shops portray religious symbols on their windows, in their stores, or advertise the presence of 'fasting foods'. Therefore, one could expect that religion is likely to impact ASF transactions with consumers preferentially self-selecting to co-religious ASF suppliers. Furthermore, social networks in Ethiopia are often co-religious because of the geographical dispersion of Muslim and Christian groups and the low levels of trust in individuals outside the own religious group. Religious groups tend to be concentrated geographically in the country, with the western regions being more dominated by Christian groups while the Eastern part of Ethiopia has a Muslim majority (see Figure 2-2, Chapter 2). General trust is rather low in the country and when asked whether individuals trust people from another religious group, only 11% indicates to trust religious out-group members completely [371]. Transactions are therefore likely to occur

predominantly within these co-religious networks. Such networks are beneficial, especially in weak institutional settings, as they reduce transaction costs by reducing information asymmetries. This is crucial for consumers who cannot readily assess the quality of milk upon transaction. Consumers very often only rely on visual inspection of milk because of the absence of milk quality standards and a functional quality control and enforcement system. This asymmetrical quality information has led to a general mistrust of consumers towards milk quality [201] making consumers prone to purchasing low or bad quality milk. Especially the latter is crucial since milk is mainly given to young children and buying bad quality milk could expose them to foodborne pathogens. Both for single and repeated transactions (in the latter case this counts for the initial selection), consumers thus have to rely on a subjective evaluation of a seller's trustworthiness and reputation in terms of milk quality when purchasing milk. Since consumers cannot readily assess the reliability and credibility of unknown sellers, they will use observable information to inform their transaction decisions. Religion is very visible in Ethiopia in clothing but also because many people wear religious symbols (crosses or headscarves). Since inter-religious trust is low in Ethiopia, it is very likely that consumers thus will have more trust in the quality of milk of a co-religious seller³⁶.

To answer our research questions, we adopt an innovative approach by implementing a discrete choice experiment (DCE). Existing studies on preferences and discrimination have very often turned to games, audit studies, or correspondence studies to study preferential and discriminatory behaviour in markets. As opposed to games, and audit and correspondence studies, DCEs allow to calculate the extent of discrimination that might be present. Adopting a DCE methodology on individuals is rather new, as it is normally used to evaluate preferences for characteristics of goods, services or programmes. We could retrieve only one study that has attempted this before, i.e. Eriksson et al. [372]

We performed this choice experiment with 250 milk consumers in the city of Mekelle, northern Ethiopia. We look at milk transactions in urban settings as urban households typically source 85% of their dairy products from purchases [8]. In the DCE we constructed, consumers were asked to imagine they move to another area (e.g. another sub-city). In this area, they want to buy one litre of milk which is offered by different potential and unknown milk sellers. Milk sellers were characterized using five different attributes that are relevant within the Ethiopian context: milk price, temporal distance to the selling point, type of seller (individual milk producer or milk shop), religious affiliation, and gender of the seller. We are particularly interested to see whether consumers use information

³⁶ In repeated transactions, producers will have less incentives to sell low or bad quality milk, since long-term interests outweigh short-term gains. If the producers would adulterate the milk with water for example (which could increase their income by being able to sell larger volumes of 'milk') this will negatively affect their reputation (i.e. long-term interest), and hence will make them lose clients. While many milk transactions are personalized, there are still a large number of occasional clients. In these one-shot transactions, producers might decide to not restrain from opportunistic behaviour.

about a seller's religious background in their buying decisions. Importantly, we account in our analysis for attribute non-attendance (ANA) as it is widely observed that respondents use simple decision rules and might not attend to all attributes included in a choice task. Not properly accounting for ANA might hence lead to biased preference coefficients [373, 374]. We use a stepwise approach to infer the ANA patterns adopted by our respondents (following the procedure of Lagarde [375]).

At first sight, the results from the 250 consumers that participated in the experiment do not show a dominant consumer preference for the religious background of milk sellers. When we accounted for ANA, we found that about half of the consumers did not consider the religious attribute in their decision-making process. However, for the subset of consumers that did attend to religion, we find evidence of a preference for co-religious sellers. Likewise, we find that although there is no overall significant preference for either male or female sellers, accounting for ANA reveals that those who attend to the attribute gender show slightly higher preferences to buy milk from female sellers, irrespective of the consumer being male or female. Milk price, distance, and type of seller are important attributes for all sampled consumers with clear and expected preferences for lower prices, shorter distances and buying from milk producers. While some consumers display clear preferences for co-religious sellers, they do not seem to trade it off to other important attributes such as distance and price.

2. Background

2.1. Religious identity, homophily and intergroup bias

Individuals categorize themselves in different social groups e.g. based on ethnicity, gender, race, religion and so forth. According to the theory of social identity developed by Tajfel et al. [376] and Tajfel and Turner [377], this social categorization inevitable involves social comparison, in which individuals compare themselves with members of another group (i.e. the out-group). This differentiation based on group membership has been linked with homophily, i.e. the tendency to interact with similar others, and intergroup bias, i.e. the tendency to evaluate and treat individuals that (are perceived to) belong to the same social group more favorably. Whereas homophily was often assumed to arise from anticipated intergroup bias, recent empirical evidence suggests that it is more likely that (subjective) uncertainty reduction drives homophily patterns [347].

Intergroup bias is the outcome of in-group favoritism, out-group hostility or both [206]. Whereas in-group favoritism represents preferential evaluation and treatment of the in-group relative to the out-group (to which the individual is indifferent), out-group hostility relates to (explicit) negative attitudes and behaviour towards out-group members. Intergroup bias can thus arise solely from in-group favoritism without any presence of negative feelings towards out-group members, and conversely it can also arise solely from out-group hostility [207]. Research has shown that intergroup bias occurs more often in the form of in-group favoritism rather than out-group hostility [208]. Intergroup bias ultimately affects intergroup behaviour and it has been extensively documented that people exhibit more in-group cooperation than out-group cooperation (for a recent review check Balliet et al. [209]), although out-group cooperation does not necessarily fall to zero [210].

Religion affiliation is one of the factors shaping one's social identity. The latest figures show that 84% of the world population identifies with a religious group [302]. Studies have reported that religious adherence affects reported attitudes, intentions and behaviour towards individuals adhering to the same religious group and individuals adhering to other religious groups. Individuals that belong to the same religious group evaluate each other more positively [378-385], and are more likely to exhibit prosocial intentions towards one another [386]. Other studies have reported negative affect, prejudice and racism towards individuals outside the religious group [381, 387-390].

Noteworthy is that so far, studies detailing the impact of religious identity on intergroup behaviour have almost exclusively focused on Northern American and western European countries. Within the African context, the available literature has predominantly studied how religious tensions and conflicts affect interreligious behaviour (see for example Oded [391], Prunier [392], Møller [393], Pew Research Center [225], and McCauley [394]).

2.2. Discriminatory practices in market transactions

Both homophily and intergroup bias involve some degree of discrimination towards others [347]. Literature on discriminatory practices has largely focused on the labour market, where employer's power to select preferred candidates is especially visible, see a recent overview published by Baert [395]. Baert [395] reviewed 90 correspondence studies in the labour market conducted between 2005 and 2016. He found that the majority of the studies were performed in Europe and North America, with nearly half of these studies focusing on ethnic discrimination. Most of the cases report discriminatory hiring practices against ethnic minorities. Research focusing on discrimination against gender, age, and sexual orientation is also common. Having a minority sexual orientation and being older is shown to significantly reduce employment opportunities. The evidence for gender is mixed, and varies along the considered occupations. Less investigated, however, is discrimination based on religious background. When studied, research mainly looked at Christian majority contexts, where they observed lower call-back rates for Muslim candidates as compared to Christian applicants [358, 396-398].

Discriminatory practices are not limited to the labour market but have also been reported in the (rental) housing market. A recent meta-analysis performed by Auspurg et al. [399] on 71 field experiments that took place in North America and Europe over the last four decades, revealed that nearly all of these trials reported discriminatory practices along ethnic lines in the rental housing market. Furthermore, discrimination against same-sex couples in the United States has been reported by Schwegman [361]. Early et al. [362] found that black households in the United States pay more rent compared to white households for identical houses in identical neighbourhoods and that this rent gap rises with the proportion of whites in the neighbourhood. Also Bayer et al. [360] found that black and Hispanic buyers pay slightly more when purchasing identical housing units. Even on online booking platforms such as Airbnb, discrimination is evident. Ahuja and Lyons [400] report that male same-sex couples are less likely to be accepted as guests by Dublin Airbnb hosts compared to female same-sex couples and heterosexual couples. Likewise, Edelman et al. [401] found discrimination by hosts on Airbnb against African Americans in five metropolises in the United States.

Product market transactions are equally impacted by social identity, but empirical evidence is still limited [402, 403]. This literature has mainly directed markets where price negotiations are common thereby focusing on differential price outcomes across different social groups. These studies document discriminatory practices by both sellers and buyers with minority buyers required to pay higher product prices while minority sellers are confronted with lower price offers. Ayres and Siegelman [363] detected that car dealers in Chicago offered significantly lower prices to white male test buyers compared to black or female candidates. List [368] detailed transactions in the sports

cards market and observed discriminatory practices against minority groups (women, non-whites and older agents) with dealers making significantly lower offers to minorities as compared to their majority counterparts. When minority groups acted as sellers, discrimination was even more evident, suggesting that buyer-side discrimination is more pronounced than seller-side discrimination. Zussman [364], who studied the Israeli online market for used cars, found that Arab buyers needed to make higher bids compared to Jewish buyers to have the same probability of receiving a response from Jewish car sellers. Additionally, also Arab car sellers received less phone calls for their online advertisements compared to Jewish sellers. Doleac and Stein [365] and Ayres et al. [366] who manipulated the skin colour of hands when advertising iPods and baseball cards online respectively, found that if the product was held by a dark-skinned hand in the picture, this product was sold at lower prices. Moreover, Doleac and Stein [365] reported fewer responses and fewer offers made when dark-skinned hands held the product. Nunley et al. [370] did similar research but changed names to signal racial background and found that buyers on eBay offered higher prices for a variety of products to sellers that shared the same racial background compared to those who had a racially distinct name. Ball et al. [404] and Li et al. [369] showed that biases still persist for artificially created groups when subjected to trading tasks. Ball et al. [404] on the one hand found that higher prices occur in markets with higher-status sellers and lower-status buyers, whereas the opposite is observed in market with higher-status buyers and lower-status sellers. Li et al. [369] on the other hand observed that sellers were more likely to make offers to buyers with the same group identity and vice versa that buyers were more likely to accept offers from sellers from their own group. Furthermore, they observed that sellers offered lower prices to buyers from another group thereby anticipating buyer's preferences for in-group sellers.

Some of the studies mentioned above have attempted to examine the causes of discrimination, by providing evidence for taste-based and/or statistical discrimination mechanisms. Differential treatment might occur because of aversion towards particular out-groups, i.e. taste-based discrimination, or because individuals use group-level information to infer unobservable but transaction-relevant information about the other economic agent, i.e. statistical discrimination. When crucial information is lacking on an individual, people use their perceptions about the average member of the group the individual adheres to so as to inform their decision making. In the labour market, for example, employers might use social identity of an applicant to make inferences about that person's productivity. Similarly, landlords can use available group membership information to assess the ability to pay rent, while in product markets it can be used to assess reservation values of buyers or sellers. To assess which of both discrimination mechanisms are at stake, some studies have exploited variation in information availability to economic agents. Hereby, it is assumed that statistical discrimination should decrease when more (transaction-relevant) information becomes

available. Taste-based discrimination, on the other hand, should not be affected by additional information provision.

In the labour and housing market, evidence supporting both sources of discrimination have been reported. The available studies on the product market do instead point more towards statistical discrimination patterns [402]. Incomplete or asymmetric information seems to be the main driver for discriminatory practices in product markets since price differences converge the more information becomes available on the credibility and reliability of sellers and/or buyers. This was confirmed by Nunley et al. [370]. In their study on transactions taking place on the online platform of eBay, they investigate how adding feedback scores to seller profiles impact buyer bids. eBay's feedback system allows buyers to score their transactions with sellers. The authors report that buyers use this information to assess the credibility of sellers. When sellers have high feedback scores, the racial background of the seller does not matter anymore for buyers who now make similar prices offers to same-race and different-race sellers both having high feedback scores.

In the above-mentioned literature, we identified three important gaps. First, social identity based on ethnicity, race, gender, and sexual orientation has received much more scholarly attention compared to religious affiliation. Since religious groups provide their members with moral frameworks, its impact on group biases and discriminatory practices might be different, and thus requires further investigation [405]. Second, insufficient research has been conducted to study the presence of biases in the product markets, and especially the food market. Third, most of the scholarly studies so far have been undertaken within high-income countries (mostly North America and Europe). There is a growing number of papers that addresses caste- and religion-based discrimination in India [352, 406, 407], but there is arguably a dearth of knowledge on the role of religion in discriminatory practices in developing countries [408]. We aim at filling these voids by providing empirical evidence on both buyer- (this chapter) and supplier-side discrimination (next chapter) using the Ethiopian milk system as a case study.

2.3. Religion and consumer purchase behaviour

Different motives drive consumers to buy specific products and to visit specific shops or stores. Scholarly literature that targets consumer purchase behaviour typically extends into informing marketing practices as it allows to identify consumer segments and to better target advertising and marketing strategies to these groups. Yet, the role of religion, and culture at large, is much less explored within this literature stream. There seem to be two important, yet separate parts of literature: one that has looked at how the social identity of consumers affects consumer purchase behaviour, independently of the store's or seller's social identity, whereas another part of literature has focused on the impact of a seller's social identity on consumer choices.

Within this first part, scholarly studies have focused on the impact of consumer's religion on shopping behaviour, looking at product choices (e.g. Sood and Nasu [99], Heiman et al. [105], and Doran and Natale [279]) and seller or store choices (e.g. Sood and Nasu [99], Essoo and Dibb [103], Swimberghe et al. [409], Choi [109], and Swimberghe et al. [410]). Research acknowledges that non-functional criteria impact consumer store loyalty and patronage. As such Segev [411] found that immigrants who value the maintenance of their original culture in a host country tend to patronize ethnic shops over mainstream stores. Likewise Jamal and Sharifuddin [412] found that part of the Muslim community in the United Kingdom values shops that offer halal labelled products. Patronizing shops that sell halal-labelled products can help to signal status, help to reinforce their identity, and to distinct them from others [413]. In severe cases, religiously inspired consumer boycotts might emerge when brands or companies violate religious beliefs and values or when stores or brands are (perceived to be) associated with a particular religious group that a consumer opposes [414-416]. Examples are the boycott against import of Danish products by several Muslim dominated countries in the aftermath of a series of cartoons published by a Danish newspaper in 2005 [417] and the Buddhists' boycott against Muslim businesses in Myanmar [418].

The other literature stream that targets the impact of a seller's social identity on consumer purchase behaviour, and thus relevant for this chapter, remains largely untapped. Few studies have looked at transactions in product markets and document that buyers offer significantly lower prices to sellers of social minority groups (e.g. women, non-whites, older people, Arabs) [364-366, 368-370]. Yet, the market value of food has been shown to be affected by the identity of the actor supplying the food, rather than its physical characteristics (such as context, flavour, texture, to name a few), a process that has been termed de-commodification. De-commodification of food implies that consumers are willing to pay a premium for food that comes from sellers with shared traits (e.g. religious affiliation) even though this food does not differ from milk sold by another seller. De-commodified food products are typically exchanged in personalized markets (450).

So far, the main focus of the shopping patronage literature has, like the social identity research, been on North America and western European countries [419]. Few studies have investigated retail choice behaviour in the African context. The studies we found mainly focus on unravelling the factors that shape consumer preferences for supermarkets vice-a-vis traditional retail outlets [257, 420-422].

3. Materials and methods

3.1. Data

We performed our study in the Mekelle milk shed, one of the eight milk sheds in Ethiopia, located in the northern part of the country. Data were collected during August-September 2017 across the seven sub-cities of Mekelle city, the regional capital of the Tigray province. We specifically focus on an urban centre, as milk markets are more developed in urban settings. In this chapter, we focus on the data we collected from interviewing urban consumers (aged 18 or above), who exclusively rely on the market to satisfy their household milk needs.

To pre-test the survey so as to optimize our experimental design, we randomly sampled 30 consumers within the city. Once the pre-test was completed, we set the total consumers to be interviewed at 220. To get a representative sample of consumers for Mekelle city as a whole, we collected a copy from the population census of Mekelle to get an overview of the total population in each of the seven sub-cities. From this, we were able to calculate the share of the Mekelle population living in each sub-city. We used these shares to calculate the number of consumers to be sampled within each sub-city. Since we did not have lists summarizing the details of these urban consumers, we had to trace them in another way. Therefore, we adopt a pragmatic approach so as to assure we draw a random sample of milk consuming households in each sub-city. To do so, we adopted a combination of the following strategies: (1) we randomly selected consumers from public places and (2) we randomly visited households' homes in the different sub-cities.

We only interviewed respondents who were aged 18 years and above and who indicated to be (co-)responsible for shopping. When the household did not consume milk, the interview was ceased and the household was not considered for data analysis. No monetary incentives were given to participate in the survey. Interviews were conducted in the local language with the help of two local enumerators that received extensive training. Two local enumerators were carefully selected and both had community field experience. The questionnaire was translated in the local language (Tigrinya) to reduce the bias that might result from different translation and interpretation of the enumerators. The questionnaire (see Appendix 3) was implemented in the Qualtrics software and enumerators were given tablets on which the questionnaire could be filled in offline. The questionnaire consisted of several modules to map respondents' characteristics (among others gender, age, and religious affiliation), household's milk consumption and purchase and household demographics. Skip and displays logics were used to move participants to questions that are applicable for their specific situation. Table 6-1 characterizes the milk consumers we interviewed.

This research was ethically approved by the Health Research Ethics Review Committee of Mekelle University as well as the ethical committee of the University Hospital Ghent.

Table 6-1: Main characteristics of the respondents and their households

Variable	Mean or proportion
Age of respondent (years)	33.4 (0.85)
Proportion female respondents	0.57
Religious background respondent (proportion)	
Orthodox	0.92
Protestant	0.02
Muslim	0.05
Other	0.01
Proportion of respondents who indicate to be the main shopping responsible	0.67
Proportion of households that consumed milk in week prior to the interview	0.59
Household size	4.58 (0.13)
Number of children	2.73 (0.15)
Monthly household income (ETB)	16,922.4 (2573.77)
Milk purchase frequency (proportion)	
Daily	0.43
4-5 times/week	0.29
2-3 times/week	0.13
Once a week or less	0.16
Main seller (proportion)	
Milk shop	0.58
Milk producer	0.24
Other	0.18
Proportion of respondents that know the name(s) of their milk seller(s)	0.48
Stated general trust (proportion)	
Most people can be trusted	0.09
You need to be very careful	0.88
I don't know	0.03
Stated trust in people of another religion (proportion)	
Trust completely	0.11
Trust somewhat	0.23
Do not trust very much	0.08
Do not trust at all	0.10
I don't know	0.48

Note: when applicable, standard errors are given in parentheses. Questions on whether respondents know the name(s) of their seller(s) and trust questions were only asked after the choice experiment was conducted.

3.2. Methodological approach

Available studies on discrimination in the labour, housing and product markets have mainly applied audit and correspondence methods in their research. However, using real buyers to study discriminatory practices requires extensive training which would be too complicated for an exploratory study in a developing context. Moreover, correspondence studies in the product market have turned to online platforms to study discriminatory practices in transactions [364-366, 370], which does not fit with the reality of milk transactions in Ethiopia.

Hence, we had to adopt an innovative approach. Directly asking respondents to detail their preferences for religious in-group or out-group trading partners is not an option, given the likely occurrence of social desirability bias. Different approaches exist to collect behavioural data and to simultaneously reduce potential social desirability biases such as the use of social desirability scales, inferred valuation techniques³⁷, bogus pipeline procedures³⁸, randomized response³⁹ and unmatched count techniques⁴⁰, and implicit association tests⁴¹. These methods have often been used in lab experiments, which offer a controlled environment. However, their usefulness in a developing context is highly questioned as they often require educated subjects and/or technological infrastructure. Game theory is another method that is being used for examining human behaviour in social situations of cooperation (e.g. prisoners' dilemmas and public good games), coordination (e.g. stag hunt) and conflict (e.g. zero-sum games) [476]. Experimental economists have been interested in behavioural changes that might occur when subjects interact with either in-group or out-group members in games. While games have been performed more often in low-income settings, they remain highly hypothetical and do not allow for a realistic operationalization of individual choices, especially not in the case of milk transactions. Furthermore, games do not allow to determine the decision weight that a respondent places on each attribute. Moreover, games might more easily trigger social desirable responding because religion is primed more in game settings due to the simplistic set-ups of commonly played games. Therefore, we turned to DCEs to elicit and quantify religious preferences.

³⁷ Techniques that ask respondents to predict or infer others' values, preferences, choices and behaviour rather than their own values, preferences, choices and behaviour [423].

³⁸ Procedure that uses objective methods (e.g. lie detector), irrespective of whether actual verification takes place, to reveal dishonesty [424].

³⁹ In randomized response techniques, respondent can answer two questions, a sensitive question and a neutral question. To determine which question will be answered a randomizing device (e.g. coins or a dice) is used. Only the respondent knows which of the two questions is answered [424].

⁴⁰ Respondents are divided in two random groups. One group has to answer a set of N questions while the other group gets the sample list of N questions plus one sensitive question [475].

⁴¹ Method that indirectly measures the strength of association between two words/concepts (for more information check Bertrand and Duflo [404]).

DCEs are stated preference methods that are used to elicit preferences for goods, services, or programmes when no revealed preference data are available. The objective of this method is to let individuals choose among hypothetical alternatives. Each alternative is described by a predefined and fixed set of characteristics, which are called attributes. The values that the attributes take, are called attribute levels. Alternatives are created by varying the levels of the attributes. By asking respondents to make choices among sets of alternatives, DCEs allow to quantify the impact of changes in the attribute levels on the choices made by respondents. DCEs have been widely applied in Western contexts and are increasingly used in developing countries [425]. Compared to other stated preferences techniques, DCEs are rather simple and straightforward and therefore more closely resemble a decision-making process. To the best of our knowledge, only one study has adopted a DCE approach to elicit preferences for individual traits rather than characteristics of goods, services or programmes, i.e. the study by Eriksson et al. [372].

In our context, DCEs have three important assets. First, DCEs offer a realistic operationalization of individual choices, since it forces participants to make trade-offs between different attributes and their associated levels. This allows to determine the decision weight that each respondent places on each attribute. Second, DCEs allow to gain insight into the extent people engage in discriminatory practices, by calculating measures such as willingness-to-pay (WTP) and/or the willingness-to-accept (WTA). Third, sensitive issues such as religion can be wrapped up among several other attributes in DCEs, making it less salient to the respondents thereby lowering the chance that respondents answer in social desirable ways that do not reflect their true preferences [426].

For the milk producers, DCEs offer an additional advantage. Since it is possible that buyers self-select to certain producer groups, one could not readily assess discriminatory practices by milk producers. DCEs allow to overcome this potentially existing sample selection by forcing producers to choose among unknown buyers.

3.2.1. Attribute selection and specification

We selected five attributes relevant to the Ethiopian dairy context to describe the seller profiles. Besides religious affiliation, we also included other non-price attributes. Non-price factors have been shown to significantly shape Ethiopian purchasing behaviour of dairy products [257]. The attributes and levels were identified through a rigorous literature review and key informant interviews. The final set of attributes and associated levels was approved appropriate and valid by a panel of local experts (Table 6-2).

Table 6-2: Seller attributes included in the choice experiment and their associated levels

Attribute	Attribute levels
Religious affiliation	Muslim – Christian
Gender	Male – Female
Milk seller	Urban milk producer – Milk shop
Milk price	17 – 18 – 19 – 20 ETB/L
Distance to seller	5 – 10 – 15 – 20 minutes

Note: distance to seller is measured via time needed to get to seller by foot, one way (from the house of the household to the seller)

Our main variable of interest is the attribute religious affiliation with two associated levels: Christian and Muslim affiliation. We did not distinguish between different Christian subgroups. We expect to find more evidence of discriminatory practices between Christians and Muslims as compared to e.g. Protestants and Orthodox. Since the latter two both belong to the broad class of Christianity, they share a higher interpersonal similarity. The social distance between both groups is thus smaller compared to the distance between Orthodox and Muslims or Protestants and Muslims. This hypothesis seems to be confirmed in our earlier study in Chapter 3, where we found that fasting practices spill over more strongly to the Muslim community as compared to the Protestant group. We signal the religious affiliation of buyers indirectly by using either names or religious symbols, a common approach in discriminatory literature [395]. Respondents were randomly assigned to either of the two groups: i.e. one group was presented with choice cards that displayed buyer names, while the other groups received choice cards in which buyers are depicted wearing religious symbols (an overview of all names and symbols included in the choice cards can be found in the Supplementary material D.1, Table S6-1 and Table S6-2). We deliberately used two mechanisms to signal the religious affiliation to control for potential social desirability bias. It has been shown that subjects tend to under- or not report their true preferences when dealing with sensitive issues so as to portray themselves more positively or because they want to gain the approval from others by acting in a socially acceptable manner [427]. It might be that overt religious preferences are undesirable; a reasonable assumption as religious discrimination is prohibited by the Ethiopian constitution. Yet,

we deliberately controlled for this by not explicitly mentioning the religious background of sellers but rather using names and religious symbols to signal the religious background instead. Whereas names are commonly used in experiments on social identity and its impact on behaviour, the use of visuals is less common. Since religious symbols more clearly indicate the religious affiliation of buyers, we expect to observe different outcomes for respondents who received choice cards with names versus those that received choice cards with religious symbols if social desirability bias is an issue in our sample.

Since we used names and religious symbols to indicate religious background, we simultaneously signalled gender. We anticipate to observe preferences for female sellers as dairy is a traditional women's business in Ethiopia. Mostly women provide day-to-day-care to the dairy herd (milking, feeding, herding, watering, cleaning the sheds) and they are the main responsible for milk processing and sales in the informal sector [428]. Furthermore, there is a general belief that women handle milk more carefully than men and deliver good milk hygiene and quality.

Third, we consider two types of sellers, namely, individual milk producers and local (specialized) milk shops. Direct marketing from milk producers is still widespread, even in urban areas, since consumers value the (perceived) freshness of milk when sourcing it directly from producers. Local specialized milk shops, on the other hand, are becoming increasingly popular in urban areas. They are convenient and allow daily purchases of small quantities of milk, which is especially relevant for those consumers that have no electricity or refrigerator [429]. In our sample, 58% of the consumers report to buy milk predominantly from milk shops, while one-fourth frequents urban milk producers. We did not consider modern retail outlets (such as supermarkets) in our choice experiment as these represent a negligible market share in our study area. Ethiopian consumers still prefer traditional retail outlets because they offer lower prices, local variety, are more convenient to shop (due their proximity) and because they are believed to sell better quality dairy products (especially in terms of freshness and flavour) [257]. Findings that were also reported by Francesconi et al. [16].

Finally, we included milk prices and distance, two important factors shaping consumer shopping behaviour [257]. Prices are commonly included in DCEs to allow calculation of the willingness-to-pay. In our DCE, price levels changed step-wise with 1 ETB from 17 to 20 ETB, which were the prevailing market prices at the time of our survey. Milk price fluctuations of 1 to 3 ETB/L are commonly observed in Ethiopia [201, 430]. Milk prices are high and there has been a (worrisome) increase in prices for nutritious foods in Ethiopia in the last decade [31, 201]. We also included distance to the seller. Whereas prices reflect how much a consumer is willing to spend more on milk sold by co-religious sellers (and thus incur extra financial costs), distances additionally reflect the time consumers are willing to endure to be able to shop milk from co-religious sellers, assuming that there is always a milk seller nearby, a valid assumption in urban areas. We detailed distance as

minutes walking one way to get to the seller's location. We used temporal distance instead of spatial distance since it allows to control for different modes of transport used by respondents.

3.2.2. Experimental design

Once the attributes and attribute levels were identified, we ran a D-efficient design using the NGENE software to construct the seller profiles. Each choice task was composed of three alternative profiles (see an example in Figure 6-1). The software generated 12 different choice tasks, which were blocked in two groups. Each respondent was randomly allocated to one block with six choice tasks. Each choice task also included an opt-out option, to avoid that respondents needed to make forced choices. The choice tasks were pre-tested with 30 consumers of which the results were also used to calculate priors to improve the experiment's final design [431]. In the final design, we randomized the order in which the choice situations were presented to avoid potential biases of ordering effects. As most of the respondents were illiterate, we supplemented the DCE with images that helped describing each of the attributes (as recommended by Bennett and Birol [432]).

Before respondents started the choice experiment, the enumerators gave a short introduction to disclose the aim of the choice task. To exclude social network effects, we started this introduction by asking participants to imagine they move to another neighbourhood (e.g. another sub-city in Mekelle). In this new sub-city, they would like to buy one litre milk. We explained the respondents that we would present them with different profiles of unknown potential milk sellers among which they can select the one they prefer most based on the described characteristics. Thereafter, we explained them elaborately the meaning of all characteristics as well as their associated levels to rule out any potential confusion. Figure 6-1 shows an example of a choice set in which religious affiliation is signalled with names and religious symbols respectively.

Weletemariam	Ahmed	Jemilla			
Shop	Farmer	Farmer	Farmer	Shop	Farmer
 20 Birr	 19 Birr	 17 Birr	 17 Birr	 20 Birr	 17 Birr
 15 minutes (one-way)	 15 minutes (one-way)	 20 minutes (one-way)	 5 minutes (one-way)	 15 minutes (one-way)	 10 minutes (one-way)

Figure 6-1: Example of choice card with names and religious symbols to choose among potential milk sellers

Note: here English translations of the choice cards are shown. The respondents received choice cards in their local language, i.e. Tigrinya.

3.2.3. Modelling strategy

According to the random utility theory of McFadden [433], choice experiments are based on the assumption that the utility that each respondent obtains from an alternative is a function of the individual characteristics describing this alternative.

In our case, the utility a milk consumer i gets from choosing a milk seller j in one of the t choice situations is expressed as follows:

$$U_{ijt} = \beta_j * X_{ijt} + \varepsilon_{ijt} \quad \text{eq. 1}$$

where X_{ijt} corresponds to the attributes of the alternative in choice situation t [434]. β_j and ε_{ijt} are not observed and treated as stochastic influences [435]. ε_{ijt} is a vector of error terms with an independent and identically distributed extreme value.

Individuals maximize their utility when making choices. Therefore, an individual will only choose alternative when the utility derived from choosing milk seller a is greater than the utilities derived from the other alternatives y in the choice set C . The probability of choosing alternative a from a choice set C with other alternatives y , is expressed as follows:

$$P(a; C) = \frac{U(a)}{\sum_{y \in C} U(y)} \quad \text{eq. 2}$$

Consumers do not have the same tastes and preferences. Therefore, we have to account for preference heterogeneity – the extent to which consumer tastes and preferences vary across consumers. Latent Class logit (LC) models and Random Parameter logit (RP) models have been the most commonly applied methods to capture unobserved preference heterogeneity in choice experiments. Both model specifications can lead to similar results, in such a case, authors tend to favour LC models since the interpretation and policy recommendations might be more straightforward. However, RP models are more flexible to accommodate preference heterogeneity and therefore these models are often applied if the research purpose requires a deeper analysis [436].

LC models assume that unobserved heterogeneity can be captured by a discrete number of latent classes in the population. Individual-specific variables such as income, age, attitudes or consumption patterns are often included to identify these different classes. These individual-specific variables are therefore considered to be the source of heterogeneity and the constructed classes are ought to be sufficient to account for the preference heterogeneity across the classes. Within the classes, homogeneous preferences are assumed and each class is associated with a different parameter vector in the corresponding utility. Once groups are formed, the obtained classes are often further

profiled exploring descriptive statistics of the respondents based on the obtained individual probabilities of belonging to certain classes.

Another set of approaches called RP models explicitly account for preference heterogeneity by allowing model parameters to vary randomly across individuals. In these models, the individual utility coefficients β_j vary across respondents, while in LC models β_j takes a finite number of values (i.e. the same number as the number of classes being identified). RP models thus allow to capture random taste variation of the respondents.

In the results section, we report the analyses of using RP models⁴². The random parameters in our model are assumed to have a uniform distribution if the attributes were categorical, while a normal distribution was used for the attribute distance as it is a continuous variables. The distributions assigned are common practices in literature. For the attribute milk price on the other hand was assumed to be invariant across individuals, because if not it would become problematic when calculating willingness-to-pay values. RP logit models assume that participants consider all available information (i.e. all the attributes) to make trade-offs and choose their preferred alternative. However, it is well documented that in actual decision situations people rather use simple rules instead of making full trade-offs. In this way, they might ignore one or more attributes [437]. Moreover, when people have dominant preferences, they might systematically ignore information about those attributes that they value less. We therefore need to account for potential ANA.

Both stated and inferred ANA⁴³ approaches have been used to estimate the extent of attribute non-attendance. Part of the literature favours inferred ANA methods over stated ANA arguing that respondents might not be able to reveal their true decision rules e.g. respondents might indicate to ignore an attribute while they actually put less weight on the considered attribute compared to the other attributes included [438, 439]. LC models allow to infer ANA by singling out different non-attendance decision rules. The econometric specifications of a LC ANA model can be found in Supplementary material D.2. Since these models allocate individuals among 2^k classes (with k

⁴² We also applied LC models so as to capture unobserved preference heterogeneity using the following individual-specific socio-economic characteristics: age and gender of the consumer, milk consumption volumes, number of children and/or number of members in a certain household, religiosity, and income. The use of religiosity profiling was also considered despite the fact that the scale selected did not capture the differences in religiosity (see more background in Supplementary Material E.3). We tried to use parts of the scale that showed sufficient variance among the respondents so as to see whether preference for the attribute religion could be explained by different levels of religiosity. Still, the LC models we ran, did not allow us to capture the unobserved heterogeneity. In the RP models we also tried to see whether accounting for the same individual-specific socio-economic characteristics with interaction terms would allow us to explain further preference heterogeneity. Also here, the analyses did not allow us to explain preference heterogeneity better.

⁴³ Stated ANA approaches ask respondents to identify and state themselves which attributes they ignored, while inferred ANA methods rely on econometric models to identify which attributes are not attended to.

representing the number of attributes and each class representing a certain ANA decision rule), testing all ANA combinations is often computationally infeasible due to sample restrictions [440].

To reduce computational problems that may arise from excessive decision rules (in our study we have 32 potential ANA decision rules), we adopt a step-wise approach to identify the specific ANA decision rule patterns that are present in our data following the approach of Lagarde [375]⁴⁴. In a first step, six classes are included, with one class representing full attendance to all attributes, while the other five classes cover those decision patterns that ignore one attribute. The algorithm allocates respondents to one of these classes. Only those classes that did not have a class probability equal to zero, were retained for the second step, in which we added classes representing non-attendance to two attributes. In the subsequent rounds, the above ascribed procedure was repeated of deleting classes with zero probability and adding classes representing non-attendance to three and four attributes respectively. The final stage is the addition of a class that represents non-attendance to all five attributes. Eventually, all respondents are classified in the classes and zero attribute coefficients are assigned to those attributes that were not attended to, while coefficients for the attended attributes take the same values across all classes [441]. Supplementary material D.3 summarizes this procedure for our data. The final ANA model (last column in Table S6-3 in Supplementary material D.3) retained eight classes.

Once the ANA decision rules present in the data have been modelled⁴⁵, the estimated individual probability of attendance can be inserted as weights in the estimation of the preference coefficients so as to further explore the preferences within the population and to estimate the mean preference weights [438, 442]. The advantage of this approach allows to include individuals who have low preferences for certain attributes, who would otherwise be categorized wrongly as non-attenders [443]. We use this weighted approach in a second stage to elicit respondents' preferences towards religion and gender in different RP model specifications. Furthermore, we additionally test for the interaction between the attribute religion and gender taking into account the religious affiliation and gender of the respondents in an attempt to observe if the interaction of these attributes could explain certain shopping patterns.

⁴⁴ In the paper of Lagarde [375], which we used as a reference, the DCE had 8 choice tasks for each respondent, with two alternatives per choice task and 133 respondents. Therefore they had 2,128 observations (since observations = number of choice tasks * number of choice alternatives * respondents). In our case, we have 6 choice tasks per respondents with 3 alternatives per choice task and 221 respondents. We therefore have 3,978 observations, and almost double the observations of Lagarde [375]. Our sample size is thus sufficiently large to adopt the procedure as set out by Lagarde [375].

⁴⁵ Additionally, in a second stage, we tried to uncover if individual-specific variables could explain why certain respondents attend a certain attribute, and why others did not. Again, we specifically focussed on the attribute religion. Also here we were not able to uncover specific patterns between individual probabilities of attendance and individual-specific characteristics.

For those preference coefficients that were found to be significant, we calculated the willingness-to-pay (WTP) and willingness-to-walk (WTW). For categorical attributes with two levels for which we used effects coding – i.e. religious affiliation, gender, and seller type – the WTP and WTW were calculated as follows [444]:

$$WTP = \left(\frac{\beta_{\text{attribute}}}{-\beta_{\text{price}}} \right) * 2 \quad \text{eq. 3}$$

$$WTW = \left(\frac{\beta_{\text{attribute}}}{-\beta_{\text{distance}}} \right) * 2 \quad \text{eq.4}$$

While for the attribute distance, which is treated as a continuous variable in the analyses, the WTP was calculated as follows:

$$WTP = \frac{\beta_{\text{distance}}}{-\beta_{\text{price}}} \quad \text{eq. 5}$$

4. Results

4.1. Consumer preferences for milk seller characteristics

Results from the first RP model we ran, without accounting for ANA, show significant preferences for distance, price and type of seller (Table 6-3). In line with our expectations, consumers prefer low milk prices and milk sellers that are located close to their homes. Furthermore, consumers prefer to buy milk directly from urban milk producers rather than from milk shops. This might be related to the perception that producers offer higher milk quality (especially in terms of freshness).

Significant preferences for the attributes religious affiliation and gender were not found, although we observe significant preference heterogeneity for the attribute religious affiliation suggested by the significant standard deviation in the second part of the table. This might imply that while overall consumers seem to be indifferent towards the religious affiliation of milk sellers, some respondents take this attribute into account when choosing to buy milk from a particular seller. Significant preference heterogeneity is also found for the attributes distance and type of seller. Although it seems irrational that consumers prefer remote sellers, it is possible that some consumers do so, potentially because these remote sellers fit better to their preferences e.g. by offering lower prices, or because they are producers rather than shops or vice versa, the sellers are female and not male (or the other way around) or because these sellers belong to the same religious group.

Table 6-3: Results from the random parameter logit model without accounting for attribute non-attendance

	β		SE
Religious affiliation (Muslim vs Christian)	-0.05		0.04
Gender (female vs male)	0.05		0.04
Seller (producer vs shop)	0.81	***	0.09
Distance (minutes)	-0.31	***	0.04
Price (ETB)	-0.48	***	0.06
	<i>SD Rand. Pars.</i>		<i>SE Rand. Pars.</i>
<i>Religious affiliation (Muslim vs Christian)</i>	<i>0.32</i>	<i>**</i>	<i>0.13</i>
<i>Gender (female vs male)</i>	<i>0.03</i>		<i>0.25</i>
<i>Seller (producer vs shop)</i>	<i>1.17</i>	<i>***</i>	<i>0.13</i>
<i>Distance (minutes)</i>	<i>0.22</i>	<i>***</i>	<i>0.04</i>
Log likelihood	-1096.77		
McFadden pseudo ρ^2	0.24		
AIC	2203.50		
BIC	2229.50		

Note: ***, ** and * represent statistical significance at a probability of less than 1%, 5%, and 10% respectively.

Part of the preference variation we observed for the three attributes religious affiliation, type of seller, and distance could be captured by considering the characteristics of the respondents. Yet, we did not succeed to fully to capture how respondents' characteristics shape different preferences. Therefore, an ANA inferred method was used to separate consumers with significant preferences for the attributes of those with no significant preferences.

4.2. Inferred attribute non-attendance

Table 6-4 gives an overview of the results of the inferred ANA LC model. We observe that only 28% of the consumers fully attended to all five attributes when choosing among different seller profiles, while nearly 11% of the respondents systematically ignored all attributes. Of the remaining respondents, 15% have made their decisions ignoring two attributes (religious affiliation and price), 18.7% ignored three attributes (seller-distance-price, gender-seller-price, religious affiliation-seller-distance, and religious affiliation-gender-seller) and 27% only attended to one attribute namely the seller type (i.e. class 29).

Table 6-4: Retained final latent class specification and average class membership share (for full detail see Supplementary material D.3)

Class number	Coefficients estimated					Final ANA model
1	$\beta_{\text{religious affiliation}}$	β_{gender}	β_{seller}	β_{distance}	β_{price}	28.03%
8	0	β_{gender}	β_{seller}	β_{distance}	0	14.90%
17	$\beta_{\text{religious affiliation}}$	β_{gender}	0	0	0	2.89%
19	$\beta_{\text{religious affiliation}}$	0	0	β_{distance}	0	11.41%
23	0	β_{gender}	0	0	β_{price}	0.38%
26	0	0	0	β_{distance}	β_{price}	3.99%
29	0	0	β_{seller}	0	0	27.42%
32	0	0	0	0	0	10.98%

Summing up the shares of those classes in which a specific attribute was attended to allows to calculate average attendance rate for each attribute. Considering those classes where religious affiliation is attended to (i.e. class 1, 17, and 19), suggests that a bit more than 40% of our respondents attended to the religious affiliation of potential milk seller profiles (Table 6-5, right column). The other respondents did not attend to the attribute religious affiliation either because they do not care about the religious affiliation of a seller or because they did not notice that the religious affiliation of a seller was included in the choice task. Yet, given the limited number of attributes included in the choice cards, we think it is very unlikely that religious affiliation would have been unnoticed by the respondents, especially because it was incorporated on the first row in the choice cards (see Figure 6-1).

Regarding the other attributes, a large majority of the consumers attended to seller type and distance, whereas half of the respondents did attend to gender and only one-third did attend to the price attribute. Reasons for the high non-attendance of this latter attribute can be ascribed to indifference to changes in the attribute [438] or to a too narrow range of the attribute levels [445]. Either forces could play a role here. We did not adopt a broader range of price levels since prices

vary little at a given moment in time due to the competitive environment of the numerous milk outlets in urban areas [258]⁴⁶.

Additionally, we asked respondents in a follow-up of the choice experiment to rank the attributes according to their importance when considering a milk seller (Table 6-5, left side). The self-reported importance ranking seems to match the average calculated attendance rates. As such 64% of the consumers indicated that the attribute seller type is the most important characteristic when choosing among different sellers. Distance and milk price were ranked as second and third, respectively, by a majority of the respondents. Religious affiliation and gender were deemed less important by most consumers. Only for the price attribute, consumers assigned a higher importance than what we would expect from the average inferred attendance to price.

Table 6-5: Comparison of self-reported importance and average attendance rate for the attributes we obtained from the inferred attribute non-attendance analysis

	Self-reported ranking of attributes					Inferred average attendance rate
	Share of respondents ranking the respective attribute... (%)					Share of respondents attending to (%)
	First	Second	Third	Fourth	Last	
Religious affiliation	1.4	4.1	5.4	58.1	30.2	42.3
Gender	6.8	9.0	6.3	60.4	17.1	46.2
Seller type	64.4	18.0	13.5	3.2	0.5	70.4
Distance	14.4	38.7	34.7	9.5	1.8	58.3
Milk price	12.6	29.7	39.6	14.4	3.6	32.4

Having uncovered the patterns and combinations of attributes attended to, the LC models allow to retrieve individual probabilities of attending to the described attributes (Figure 6-2). We find quite uniform distributions of the probabilities of having attended to religious affiliation, gender and distance, suggesting heterogeneity in decision patterns. Some respondents consistently attend, while others attend to none of these attributes. Yet, the probability of having attended to religious affiliation is slightly skewed to the right, suggesting that religious affiliation was less likely to have been attended to whereas the opposite holds for distance. The distribution for attendance probability of seller type and price are more clearly skewed. The left skewness of the price attribute suggests that this attribute was less likely to be attended to, whereas the right skewness of the seller type attribute indicates that most of the respondents took seller type into account.

⁴⁶ Still, milk prices fluctuate significantly across seasons in Ethiopia. Climatic fluctuations, most importantly rainfall patterns, as well as periodic occurrence of Orthodox fasting practices and feasts have been shown to affect milk production and price setting [17].

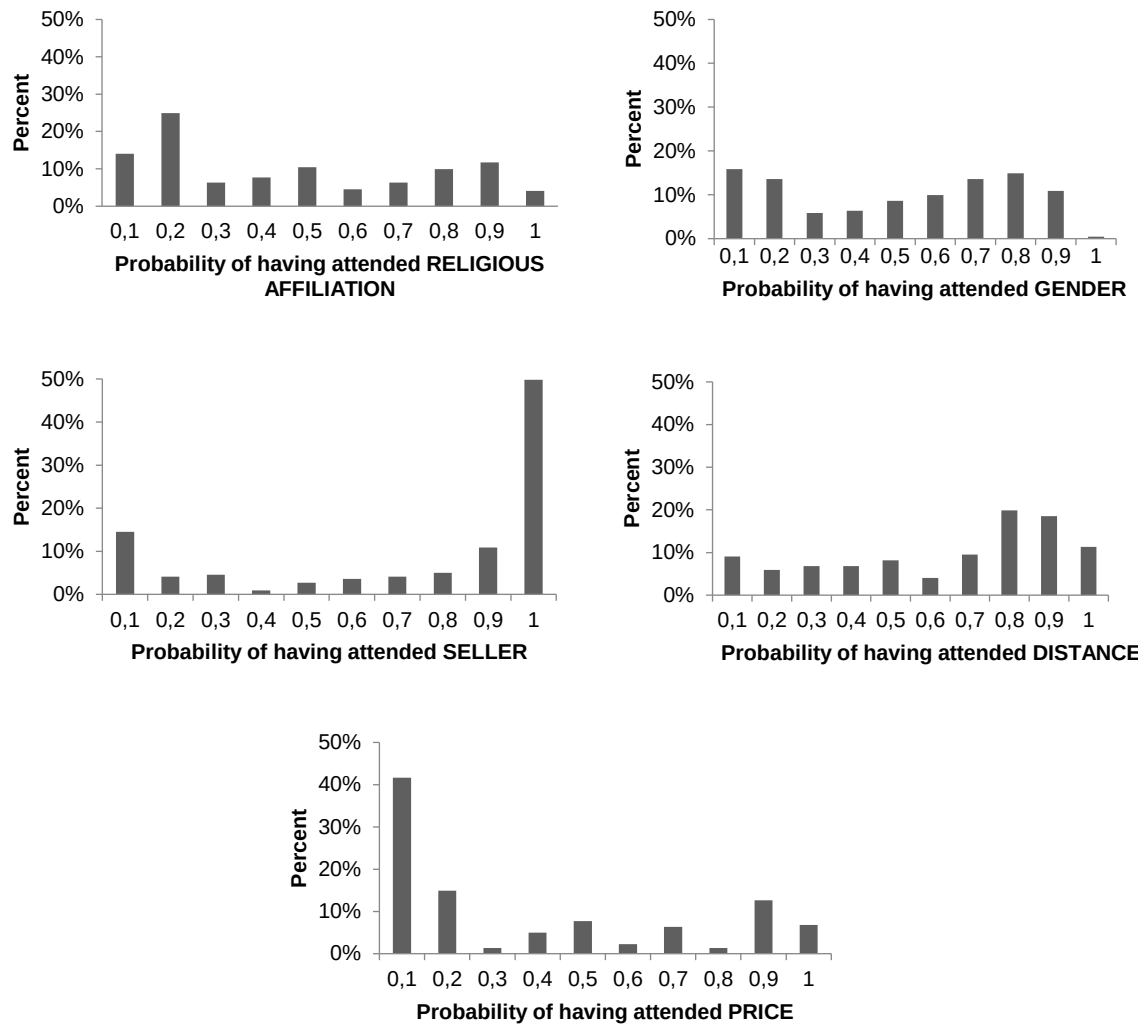


Figure 6-2: Distribution of individual probabilities of having attended to each of the attributes

4.3. Does religious affiliation matter?

This section aims at answering the following two questions: (1) do consumers consider the religious affiliation of sellers when choosing from whom to buy milk and (2) if they do consider religious affiliation, do they prefer co-religious sellers?

From the results of the RP model detailed above (Table 6-3), we observed that on average, consumers do not consider religious affiliation of major importance when choosing among different milk sellers. Yet, because we observed significant preference heterogeneity around this attribute, which could not be explained by varying consumer characteristics, we argued that non-attendance to this attribute could explain significant preference heterogeneity for religious affiliation. Inferring the ANA patterns present among the respondents revealed that about half of the consumers did not attend to the attribute religious affiliation.

In this section, we re-ran our RP model weighting the preference coefficients with the individual probabilities of attendance we attained from the inferred ANA approach. Furthermore, we defined different specifications of the attributes religious affiliation and gender. In the first RP models (models 1 and 4), we look at the religious affiliation and gender of the seller but not that of the consumer. To elaborate our findings, we added two new model specifications (Table 6-6): one in which we model preference for sellers with a similar religious background or the same gender as the consumer (models 2 and 5); and preference for either the same religious affiliation, same gender or both (models 3 and 6). The left panel of Table 6-6 highlights the dominant preferences of the consumers (without considering ANA), while the right panel shows the weighted preference coefficients by considering individual attendance probabilities for the different attributes.

Table 6-6: Random parameter models for different specifications of the attributes religious affiliation and gender without (left) and with (right) considering individual attendance probabilities

	RP models without weighting			RP models with weighting		
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
	β (SE)	β (SE)	β (SE)	β (SE)	β (SE)	β (SE)
Seller (farmer vs shop)	0.81*** (0.09)	0.81*** (0.09)	0.80*** (0.09)	1.48*** (0.09)	1.42*** (0.08)	1.42*** (0.08)
Distance (minutes)	-0.31*** (0.04)	-0.32*** (0.04)	-0.32*** (0.04)	-0.92*** (0.07)	-0.95*** (0.07)	-0.95*** (0.07)
Price (ETB)	-0.48*** (0.06)	-0.48*** (0.06)	-0.49*** (0.06)	-2.64*** (0.17)	-2.79*** (0.17)	-2.79*** (0.17)
Religious affiliation (Muslim vs Christian)	-0.05 (0.04)	-	-	-0.36*** (0.09)	-	-
Gender (female vs male)	0.05 (0.04)	-	-	0.41*** (0.10)	-	-
Same religious affiliation vs different religious affiliation	-	0.04 (0.04)	-	-	0.32*** (0.10)	-
Same gender vs different gender	-	0.03 (0.04)	-	-	0.14 (0.09)	-
Same religious affiliation vs different religious affiliation and gender	-	-	0.08 (0.07)	-	-	0.40** (0.19)
Same gender vs different religious affiliation and gender	-	-	0.06 (0.06)	-	-	0.00 (0.15)
Same religious affiliation and gender vs different religious affiliation and gender	-	-	0.01 (0.05)	-	-	0.29 (0.27)
	<i>SD Rand. Pars (SE Rand. Pars.)</i>	<i>SD. Rand. Pars (SE Rand. Pars.)</i>	<i>SD Rand. Pars (SE Rand. Pars.)</i>	<i>SD Rand. Pars (SE Rand. Pars.)</i>	<i>SD Rand. Pars (SE Rand. Pars.)</i>	<i>SD Rand. Pars (SE Rand. Pars.)</i>
Seller (farmer vs shop)	1.17*** (0.13)	1.18*** (0.14)	1.15*** (0.13)	0.014 (0.19)	0.01 (0.18)	0.01 (0.18)
Distance (minutes)	0.22*** (0.04)	0.23*** (0.18)	0.23*** (0.04)	0.00 (0.06)	0.00 (0.36)	0.00 (0.06)
Religious affiliation (Muslim vs Christian)	0.32** (0.13)	-	-	0.33 (0.40)	-	-
Gender (female vs male)	0.03 (0.25)	-	-	0.08 (0.29)	-	-
Same religious affiliation vs different religious affiliation	-	0.3** (0.15)	-	-	0.79*** (0.28)	-
Same gender vs different Gender	-	0.17 (0.18)	-	-	0.02 (0.36)	-
Same religious affiliation vs different religious affiliation and gender	-	-	0.53** (0.26)	-	-	0.84 (0.61)
Same gender vs different religious affiliation and gender	-	-	0.45* (0.25)	-	-	0.13 (0.50)
Same religious affiliation and gender vs different religious affiliation and gender	-	-	0.07 (0.37)	-	-	1.16** (0.53)
R ²	0.27	0.27	0.27	0.52	0.51	0.51
Log likelihood	-1052.56	-1053.49	-1052.72	-698.88	-708.71	-709.32

Note: ***, **, * indicate significance at 1%, 5%, 10% level, respectively.

As expected, we could not detect significant preferences for either religious affiliation or gender in any of the specifications if we did account not for ANA (models 1-3). All these RP specifications, however, show significant preference heterogeneity around the religious affiliation estimates, indicating that preference for religious affiliation varies significantly across our milk consumers in Ethiopia. When we account for ANA (models 4-6), we find that consumers significantly prefer co-religious sellers, while they seem not to care whether or not the sellers share the same gender. We rather observe a preference for female sellers, independently of the respondent being male or female. Another interesting result is that accounting for the individual attendance probabilities removes part of the heterogeneity around the estimated random parameter coefficients which implies that part of the preference heterogeneity we observe can thus be explained by ANA patterns.

For those attributes that were found to be significant, we are able to calculate WTPs and WTWs, so as to quantify trade-offs between the price or distance and the rest of the attributes considered. The difference in estimated WTPs and WTWs across the models is small. In the RP models without weighting (models 1-3), each additional minute walking to the selling point reduces the WTP with 0.65-0.67 ETB per L of milk. Additionally, consumers are willing to pay 3.27-3.38 ETB more or to walk 5-5.23 minutes longer to buy milk from an urban producer as compared to a milk shop. In the weighted RP models (model 4-6), the reduction in WTP for each additional minute walking is 0.34-0.35 ETB, while the WTP and the WTW for a milk producer was 1.02-1.12 ETB more and 2.99-3.21 minutes longer as compared to a milk shop.

In the weighted RP model 4, we calculated the WTP and WTW to buy milk from Christian sellers. We find that consumers are willing to pay 0.27 ETB more for 1 L of milk sold by Christian sellers versus Muslim sellers, and they are willing to walk 0.78 minutes longer for Christian milk sellers. Moreover, consumers are willing to pay 0.31 ETB more and walk 0.89 minutes longer when milk is sold by female sellers. When consumers and sellers share the same religious affiliation, consumers are willing to pay 0.23-0.29 ETB more and walk 0.42-0.84 minutes longer than when they do not share the same religious affiliation (model 5 and 6).

5. Discussion

From the above analysis it is clear that the most important attribute for Ethiopian consumer is the type of milk sellers, with a clear and strong preference to buy milk from milk producers. Informal discussions with our respondents revealed that they attribute a higher quality to the milk bought from milk farmers and they seem to trust them more than shop sellers. Consumers argued that milk shops sometimes dilute milk so as to increase profits. Furthermore, milk sourced directly from farmers is perceived to be fresher. It seems that both trust and perceived quality make urban consumers more inclined to shop from dairy farmers. To alter consumer purchase behaviour to milk shops and other retail outlets will require public investment in quality standards so as to provide reliable and trustworthy information on milk safety and quality to consumers [258].

Furthermore, we observe that consumers value proximity of milk outlets (convenience). At present, there are still more urban milk producers as compared to milk shops, which might also explain why consumers still patronize local milk producers. Both gender and religious affiliation of the milk producers are no decisive factors when deciding from whom to buy milk. Yet, we observe low attendance rates for both attributes, which could explain why we do not find dominant preferences for either attributes. Since milk is typically traded in small quantities, consumers can easily shift to other sellers if they are not satisfied. This flexibility could explain why not all consumers do not pay attention to the social identity of sellers, but rather focus on characteristics they value more, which seem to be the type of seller, proximity of the seller and milk prices. Alternatively, since we performed this study in an almost exclusive Christian setting, most transactions already occur between Christian consumers and Christian sellers which could potentially make the consumers in our sample less sensitive for the religious attribute.

When accounting for ANA, we observe that part of our consumers does take religious affiliation and gender into account when deciding to engage in milk transactions and tend to self-select to female and co-religious sellers. Since the large majority of our sample is Christian, we observe preferences for Christian sellers. Consumers do not self-select to sellers with the same gender. Moreover, while consumers seem to have a clear preference for co-religious sellers if they indicate to value religion in making their purchase decisions, the type of supplier remains the most important factor when deciding from whom to buy milk, as can be seen from the higher WTP and WTW for milk producers as compared to the WTP and WTW for Christian sellers.

Previous studies that focused on discriminatory practices in product markets (mostly online platforms) found that buyers are less likely to transact with out-group members and if they do, they make significantly lower offers to out-group sellers, while they offer higher prices for in-group sellers [365, 366, 368, 370]. Yet, these studies focus on markets with many potential sellers and non-food

products. Our findings thus do not refute what is expected from theory (i.e. homophily and discriminatory practices in the light of informational asymmetries), but stress the need for more studies to be performed, on food transactions in general but also in different religious settings, e.g. more mixed settings. Repeating this choice experiment in different settings is also needed to validate whether our results also hold for non-Christian consumers, for which we now have too few observations to make solid conclusions. Future studies could also benefit from focusing on larger sample sizes so as to better assure that the sampled respondents are accurately representing the population. Moreover, future studies could benefit from incentivized decisions, where respondents' decisions are coupled with actual payments, so that the decisions made are a more realistic representation of the respondents' true underlying preferences.

Finally, the actual impact of religion on real-world transaction decisions is expected to be bigger especially because many transactions happen within social networks that often are or have been established by sharing religious ties. In the DCE we constructed, we avoid that social network effects impact the choices of our respondents, by asking respondents to imagine they move to another area (e.g. another sub-city). The effect we measure with this experiment thus captures only the impact of religion on milk transactions, as we make religion exogenous from social network effects.

6. Conclusion

This chapter adds empirical evidence to the literature on consumer behaviour. Using a discrete choice model, we assessed consumer preferences for the religious affiliation of milk sellers together with other characteristics describing alternative milk seller profiles in Ethiopia (i.e. gender, seller type, milk price and temporal distance to selling point). Running different specifications with random parameters models, we could not find significant consumer preferences for co-religious milk sellers. We attribute this to respondents not placing dominant preferences for religious affiliation in our sample, either due to respondents ignoring the religious attribute or placing low preference on the religious background of the seller. Using a stepwise latent class approach, we inferred that less than half of our respondents attended to the attribute religious affiliation when making their choices. Further analysis considering attribute non-attendance revealed that those consumers who consider the religious background when assessing different seller profiles, reveal preferences for co-religious sellers, which in our sample corresponded to Christian sellers given the dominance of Christian consumers. For the other included seller characteristics, respondents displayed economic rational behaviour by selecting those sellers that offer lower milk prices and are closer located to their homes. Furthermore, consumers overall prefer to buy milk directly from urban milk producers, which can be attributed to the perceived higher quality of milk offered by farmers as compared to shops. Consumers did not reveal a dominant preference for female sellers, but those consumers that care display a preference for female sellers, irrespective of the consumer being male or female.

We show that an important sub-set of the consumers we interviewed consider the religious identity of potential milk sellers in their purchase decisions and they are willing to pay more and walk further to buy milk from Christian sellers. Consumers in our sample thus (in)consciously self-select to co-religious sellers, which might inhibit a proper milk market functioning and contribute to religious market segmentation. Our findings are in line with what is expected from theory. More studies are needed to validate our findings in others religious settings in the country as well as for non-Christian consumers. Furthermore, more research in general is needed to elaborate the impact of social identity on economic transactions and economic behaviour at large.

CHAPTER 7

Is religion cueing trading behaviour? Evidence from Ethiopian milk producers

Working paper with Juan Tur Cardona and Prof. dr. ir. Stijn Speelman (research group on Economics and management of natural resources, department of Agricultural Economics, Ghent University)

Abstract

Low levels of trust and high levels of uncertainty are likely to make individuals preferentially trade with members who belong to the same social group so as to reduce transaction costs. This might result in trade breakdown across social groups. Ethnic market segmentation has been evidence in Africa, but insufficient studies have looked at religious market segmentation. We contribute at filling this void, by examining if religion impacts milk transactions in the Ethiopian value chain. In the previous chapter, we investigated whether milk consumers discriminate among potential milk seller candidates based on their religious affiliation. We find that an important sub-set of consumers preferentially selects co-religious sellers. In this chapter, we apply a similar choice experiment (albeit with some different attributes) to study whether milk producers discriminate against potential milk buyers based on their religious affiliation. Since the pool of potential buyers is large in cities with only few producers operating in these areas, producers are able to choose to whom they sell their milk to. We expect that discrimination mostly occurs by selecting the buyers on their personal characteristics since there is limited possibility for both price and quality differentiation by producers. We find that on average, milk producers do not reveal significant preferences for co-religious buyers. Yet, we observe significant preference heterogeneity around this attribute. This implies that some producers have strong preferences for the religious affiliation of milk buyers, while others have less or no preference. The results from our experiment should be seen as a lower estimate. Future studies would benefit from repeating this experiment in different religious settings and from including sales volumes as an attribute in the experiment to see whether religious preferences become more pronounced when larger volumes of milk are involved in the transactions.

Keywords: choice experiment, Ethiopia, market segmentation, milk transactions, producers, Mekelle city, religious ties, trading preferences

1. Introduction

This chapter builds further on the theory of homophily and discriminatory practices in markets that were introduced in the previous chapter. The available literature on discrimination in product markets usually takes a buyer perspective and studies discriminatory practices in markets where there is usually a large pool of potential sellers (online platforms). In this paper, we take a seller approach and aim at investigating whether sellers discriminate among buyer groups. The studies that have taken this approach as well usually focus on price discrimination and find that sellers require minority buyers to pay higher product prices [363, 364]. Li et al. [369] on the other hand focused on offers made by sellers to different buyer groups and find that sellers were more likely to make offers to buyers with the same group identity. This evidences that not only buyers consider the seller' social identity but that also sellers consider the social identity of potential buyers and treat buyers differently in economic transactions.

Cultural similarity can help to establish the necessary interpersonal trust between two (or more) trading agents. Yet, relatively few studies have tried to unravel the role culture plays in facilitating market transactions. The available scholarly literature mainly focuses on Europe and North America and confirms that cultural similarity fosters cross-border trade [204, 446], cross-border acquisitions [447], and cross-border alliances [448, 449]. This cultural sorting process can be beneficial for economic performance [448] but might also result in significant costs that lock economic agents in inefficient trade relations [449].

In SSA, there is some evidence of the formation of ethnic trading networks [19, 20, 450-454]. Being both member of the same social group (in this case ethnic group), creates expectations of trustworthy behaviour between seller and buyer, even when trading agents do not know each other personally. These expectations reduce sellers' search and screening costs for potential trading partners. Moreover, social groups typically accommodate moral norms for appropriate behaviour and facilitate sanctions in the case of default [455-458]. When social groups are geographically dispersed and trust is primarily concentrated within these groups, economic exchange will predominantly occur between members of the same social group. Through repeated interactions, trading arrangements based on a shared social identity can turn into long-lasting patron-client relations [459]. This results in market segmentation, which will obviously come at a transaction and welfare cost for the society [20]. While there is some evidence of ethnic market segmentation, the existence of religious market segmentation has received insufficient scholarly attention.

This chapter contributes toward filling this void. We do so by examining if religion interferes with food transactions in Ethiopia, taking the specific case of milk. The Ethiopian milk market is plagued by several problems which result in considerable market inefficiencies. The existence of coordination problems that impede a proper market functioning, however, has not yet received sufficient attention.

We therefore look at milk transactions in urban settings characterized by market-oriented milk production – with 75% or more of the produced milk being marketed by milk producers [460] – and a large and diverse buyer pool – individual consumers, FSPs, and traders. In the previous chapter, we detailed the impact of a seller's religious identity on consumers' purchase decisions. We find that an important sub-set of the consumers we interviewed consider the religious identity of milk sellers in their purchase decisions and prefer to purchase milk from co-religious sellers. These consumers are also willing to pay more and walk further to buy milk from co-religious sellers. In this chapter, we look at the producer side and since it is possible that religious bias also occurs at the producer side. Since there are few producers in urban areas versus many potential buyers, producers might be picky to whom they sell their milk to and prefer to sell to co-religious consumers.

As explained in the previous chapter, we hypothesize that religion might be an important factor in a seller's (initial) selection of milk buyers because of (1) the milk market that operates predominantly informally, (2) the religious symbolism of ASFs, and (3) the widespread occurrence of co-religious networks due to low levels of trust in other religious groups and the geographical dispersion of religious groups. Also for producers, informational asymmetries occur that require trust from producers in milk buyers, which can be solved by trading within co-religious networks. Additionally, these networks lower sales costs and can potentially reduce the effect of fasting periods by creating a bonding mechanism.

Due to the perishability of milk and lack of proper storage and cooling infrastructure, milk sales occur daily, with most farmers selling small quantities of milk to various buyers. In the Ethiopian milk market both spot market transactions⁴⁷ and short-term contracts occur. Whereas in an anonymous spot market transactions milk is directly exchanged and paid, on-credit-sales (delayed payments) and exchange of information are common in short-term contracts. As uncertainty increases in these latter transactions, especially since there are no intermediate institutions to facilitate transactions and enforce agreements, transaction costs rise. Such short-term contracts can only arise when sufficient interpersonal trust is established between buyers and sellers and therefore most of these transactions are highly personalized. Such personalized transactions very often arise within social networks, which in Ethiopia, are often co-religious. But, in urbanized settings with many potential buyers and thus a high demand for milk, producers frequently sell to unknown and occasional buyers. We hypothesize that when these transactions involve delayed payments, producers will preferentially trade with buyers belonging to the same religious group because of the low levels of trust reported for people outside the own religious group. Delayed payments are prone to

⁴⁷ Transactions are characterized by asset specificity, uncertainty and frequency [461]. Since milk is a generic good, spot markets are likely to emerge as both sellers and buyers can find other trade partners easily. Continuity of transaction is thus not required as both trading partners do not depend on each other. Since milk transactions are non-asset specific, uncertainty does not affect these transactions largely.

opportunistic behaviour of buyers, since buyers have an incentive to default (at least short-term) [454]. Producers might only be inclined to accept delayed payment if they believe that the buyer will not refrain from paying later. Therefore, the producer will prefer to transact with a buyer who is believed to be more trustworthy. Since religion is readily observable, producers might use this information when selecting among different potential and unknown milk buyers. If milk producers prefer to collude with co-religious milk buyers, producers might make milk, a highly nutritious food product, socially inaccessible to certain buyer groups.

We expect that producers will mostly discriminate when choosing to whom they sell their milk to, since they have little possibility to differentiate on quality and price among buyers from different religious groups. Based on the findings from studies on discriminatory practices in products markets (see Chapter 6), one would expect that producers charge higher milk prices for religious out-group buyers. Price differentiation in the Ethiopian milk chain is however not standard. Brands and labels are not common in the country which could justify price differentiation for milk. Moreover, milk quality standards and grades are largely absent, and a functional quality control and enforcement system is lacking, thereby making it even more difficult to differentiate milk based on e.g. fat or lactose content. All these factors make milk a rather homogenous product, for which it is hard to establish and justify price differentiation.

Next to price discrimination, producers could also deliberately adulterate the milk with water (which is a common practice in Ethiopia [201]) when selling milk to other religious groups. This is possible since buyers cannot adequately assess the quality of the milk upon transaction, due to the lack of proper quality control. Yet, this is also not likely to happen, since milk sold by producers is bulked in plastic containers (jerry cans) making it highly unlikely that producers would start to adulterate milk for those buyers that do not share the same religious affiliation.

To answer our research question, we again adopt a DCE. In the DCE we constructed, producers were asked to choose among different potential and unknown milk buyers. Milk buyers were characterized using five different attributes that are relevant within the Ethiopian context: milk price, payment terms (at the time of transaction or delayed), type of buyer (individual consumer, shop, or trader), religious affiliation and gender of the buyer.

Using a sample of 250 milk producers located in the city of Mekelle, we find that milk price, payment terms and type of buyer are important attributes to all sampled producers with clear and expected preferences for higher prices and immediate payment. We observe that producers prefer to exchange with traders over individual consumers, and individual consumers over milk shops. The preference for traders is rather surprising, given that only 8% of the milk producers indicated that traders are currently their main buyers. We found only a few traders who are operating in the city and link urban producers to urban customers, probably because of the lack of (wholesale) demand

in the area and/or the limited profit margins of traders when they operate within the city. Despite the lack of traders in the city, producers still seem to prefer them probably because traders source larger volumes of milk as compared to individual consumers and are less strict on milk quality as compared to milk shops. Moreover, we suspect that milk producers value interlocked contracts as traders usually provide inputs to milk producers, especially feed, which is interesting for urban producers who rarely grow feed themselves.

We find that milk producers on average do not show dominant preferences for co-religious buyers. But, we observe significant preference heterogeneity around the attribute religious affiliation, suggesting that some producers have strong preferences for the religious affiliation of buyers while others have less or no preference. We were not able to statistically explain this heterogeneity by accounting for ANA and respondent characteristics in our models. Furthermore, we find that producers, when confronted with unknown milk buyers in a single-shot transaction, reveal preferences for spot market transactions (signalled by their preference for immediate payment). This implies that most producers do not invest high searching and screening costs to find reliable buyers when the transaction involves only one litre of milk. The preference for immediate payment might also explain why we did not observe a dominant preference for the religious affiliation of milk buyers. Future studies would benefit from (1) repeating this experiment in different religious settings, and (2) including sales volumes as an attribute in the experiment to see whether religious preferences become more pronounced when larger volumes of milk are involved in the transactions.

2. Ethnic market segmentation in Africa

In weakly institutionalized settings, a particular challenge in developing nations, interpersonal trust is an important precondition for trade. In many of these countries, market imperfections and the absence of an effective legal system to enforce contracts and settle contract disputes result in high transaction costs that impede economic exchange [20]. Trading among in-group members is associated with more trust even if individuals might incur higher transaction costs [20]. For example, Foschaches et al. [462] found that social identity matters more than transactional attributes do when rural producers in Brazil have to decide among different marketing channels to commercialize their produce.

Also, other studies have highlighted the importance of shared group membership in establishing close personalized trade relationships. Within the African context, Fafchamps [454] observed ethnic concentration in agricultural trade in Benin, Malawi and Madagascar. Also in Ethiopia, the importance of sharing religious or ethnic ties has been shown among farmers and middlemen in the potato value chain [463]. Gelaw et al. [464] report that 28% of the Ethiopian coffee farmers they interviewed reported that they had established close trading relations with trader(s) of the same social group. Patron-client relations were omnipresent and strong in the research area and 81% of the farmers reported that once patron-client relations were established, they never or rarely sold their produce to other traders. When such trading preferences result in the establishment of exclusive networks, agents might get locked into non-profitable transactions. As such, Ali and Peerlings [465] observed that ethnically tied small-scale handloom producers in Ethiopia have significantly lower monthly profits.

Trading preferences based on social identity can reduce intergroup trade, and ultimately result in market segregation or segmentation [20]. Market segmentation along ethnic lines has been observed within the maize value chain in Malawi [20]. Farmers and traders prefer to trade with co-ethnic partners, which they report to trust more. Trust is important to overcome the risks associated with maize trade, they highlight. There is a common belief that it is easier to locate and sanction a co-ethnic trading partner in the case of default. A large majority of the interviewed farmers declare that the main cause for intra-national market barriers was the weak trust between ethnic groups [20]. Along the same lines, Aker et al. [19] found that price differences in Niger for millet and cowpea are smaller in trade flows between ethnically similar regions. Moreover, when looking at the Niger-Nigeria border trade, they observe smaller price dispersion when markets on either side of the border share the same ethnicity.

As ethnic affiliation, religion may lead to market segmentation. However, religious market segmentation has been less studied. The dietary laws laid out by the Muslim and Jewish community contribute to the proliferation of separate market and distribution channels. These laws prescribe

their members to consume halal and kosher food respectively, thereby imposing followers to purchase from sellers that offer halal and kosher products. For meat and poultry, the spread of separate halal supply chains (to avoid contamination), halal labels and certification schemes targeting local Muslim consumers in non-Muslim majority countries has been discussed in literature for Europe see e.g. Lever and Miele [466] and Lever and Fischer [197]. The above studies exemplify the impact of religious instructions on market organization. Less clear however is how religion might affect trading preferences of producers which could potentially lead to market segmentation.

3. Materials and methods

3.1. Data

We performed our study in the Mekelle milk shed, one of the eight milk sheds in Ethiopia, located in the northern part of the country. Data were collected during August-September 2017 across the seven sub-cities of Mekelle city, the regional capital of the Tigray province. We specifically focus on an urban centre, as milk markets are more developed in urban settings. Milk producers in urban centres typically sell the majority of their production (estimated at 75% or more by Ayenew and Wurzinger [460]).

To pre-test the survey so as to optimize our experimental design, we randomly sampled 30 producers within the city. Once the pre-test was completed, we set the total producers to be interviewed at 220. To get a representative sample of producers for Mekelle city as a whole, we collected estimates of urban milk producers operating in each sub-city from the respective sub-city administrations so as to get an overview of the total population of dairy producers in the city. From this, we were able to calculate the share of milk producers in each sub-city. We used these shares to calculate the number of producers to be sampled within each sub-city. Since no lists are available summarizing the details of these urban dairy producers, we had to trace producers in another way. Therefore, we adopt a pragmatic approach so as to assure we draw a random sample of dairy producing households in each sub-city. To do so, we adopted a combination of the following strategies: (1) milk producing households in Mekelle often let their manure to dry outside their homes, which we could use to trace them; (2) we asked around in the respective sub-cities, usually a causal passer-by, where we could find milk producers; and (3) after having interviewed the dairy producers, we asked them where we could find other producing households in the sub-city. Please note that this sample is a different group of dairy producers than those on which Chapter 5 is based.

Interviews were done with the household member responsible for the dairy farm and/or dairy sales (household head or spouse). No monetary incentives were given to participate in the survey. These milk producers were interviewed at the same time when we conducted the interviews with the milk consumers included in the previous chapter. The survey and the choice experiment were very similar to the one administered with milk consumers and can be found in Appendix 3.

This research was ethically approved by the Health Research Ethics Review Committee of Mekelle University as well as the ethical committee of the University Hospital Ghent.

3.2. Methodological approach

3.2.1. Attribute selection and specification

We selected five attributes that are relevant within the Ethiopian milk context to describe the buyer profiles. An initial set of attributes and levels were identified through a rigorous literature review. To tailor our DCE to the study setting, we interviewed local experts as well as a sample of 30 milk producers in Mekelle so that our final set of attributes and associated levels (Table 7-1) was appropriate and valid.

Religious background was signalled using names or religious symbols (the same names and religious symbols were used as in Chapter 6, see Supplementary material D.1). Since we use names and symbols incorporated in drawings (see Figure 7-1) to indicate religious background, we simultaneously signal gender. We hypothesize that gender might play a role in milk transactions. We assume that milk producers are more confronted with female buyers since women are the main responsible for food purchasing and food preparation [467]. Producers might thus reveal slight preferences for female buyers, especially when these buyers are individual consumers.

Since different buyer types occur, we used this variation so as to mirror reality. Moreover, from earlier studies we observed that producers tend to sell their produce to different buyers (see Chapter 4 and 5). We thus included the three most common milk outlets for producers, i.e. individual consumers, milk shops, and traders. Given the growing importance of milk shops, we deliberately focus on this FSP. Shops offer advantages to producers, since they can buy larger volumes of milk. Also, traders remain important intermediaries in the Ethiopian milk value chain, linking producers with retailers, FSPs, or processors. We did not consider modern retail outlets, such as supermarkets, as these represent a negligible market share in our research area.

Finally, we include two instruments to investigate discrimination practices: i.e. milk prices and payment terms. Prices are commonly included in DCEs to calculate WTPs. Including prices allows to investigate the extent of discrimination of milk producers towards particular buyer groups. Yet, since milk prices are market determined, and producers cannot easily set their own prices, it is more interesting to use payment terms. Delayed payment is a common practice in Ethiopia, but it is prone to opportunistic behaviour of buyers, since buyers have an incentive to default (at least short-term) [454]. Producers might only be inclined to accept delayed payment if they believe that the buyer will not refrain from paying later. Therefore, the producer will prefer to transact with a buyer who is believed to be more trustworthy. We hypothesize that sharing religious ties might act as a proxy for trustworthiness in our controlled experimental setting. If discrimination is present, we expect to observe that producers allow co-religious buyers to pay later while the opposite would hold for buyers with another religious background. The milk price levels in our experiment ranged between 17-20 ETB (0.73-0.86 USD, accounting for the exchange rates at the time of data collection). This was the

prevailing price range at the time of data collection. These prices are high, which is a common observation in cities across Ethiopia [17]. On the choice cards, prices vary by 1 ETB following the advice of local experts and the milk producers we interviewed while pre-testing the survey. The competitiveness of the markets with numerous milk sellers results in such small price variations. Similar price fluctuations have been reported by Zijlstra et al. [201] and Brasesco et al. [430].

Table 7-1: Buyer attributes included in the choice experiment and their associated levels

Attribute	Attribute levels
Religious affiliation	Muslim – Christian
Gender	Male – Female
Milk buyer	Individual consumer – Milk shop – Trader
Milk price	17 – 18 – 19 – 20 ETB/L
Payment terms	Immediate (i.e. at the time of transaction) – Delayed

3.2.2. Experimental design

Using the NGENE software, the five attributes were combined into a D-efficient design in which each choice task was composed of three alternative profiles (see an example in Figure 7-1). The software generated 12 different choice situations or tasks, which were blocked in two groups. Each respondent was randomly allocated to one block with six choice tasks. Each choice task also included an opt-out option, to avoid that respondents needed to make forced choices. The choice tasks were pre-tested with 30 producers of which the results were also used to calculate priors to improve the experiment's final design.

Also here, we asked to producers to imagine they have moved to another area, so as to avoid that social network effects impact the choices of our respondents. The transaction volume again consisted of one litre milk, which was explicitly stated to the respondents so as to rule out potential expectations about different purchasing volumes associated with different buyer types.

Abraham	Fatuma	Kidus			
Trader	Trader	Consumer	Trader	Shop	Consumer
 20 Birr	 19 Birr	 17 Birr	 17 Birr	 20 Birr	 17 Birr
 Delayed payment	 Immediate payment	 Immediate payment	 Delayed payment	 Immediate payment	 Delayed payment

Figure 7-1: Example of choice card with names and religious symbols to choose among potential milk buyers

Note: here English translations of the choice cards are shown. The respondents received choice cards in their local language, i.e. Tigrinya.

3.2.3. Modelling strategy

To determine general preferences for milk buyer characteristics, we used the same models as detailed in Chapter 6. We report the results from RP models⁴⁸ which allow to account for the variation of preferences across individual respondents [468] (see econometric specifications in Chapter 6). In these models, we additionally control for the interaction between the attribute religion and gender (taking into account the religious affiliation and gender of the respondents), as well as the interaction of religion with payment terms, since we hypothesize that delayed payments might make religion crucial when selecting among unknown milk buyers.

We further explored preference heterogeneity by including interaction terms between choice attributes and individual-specific characteristics (age, gender, milk production volumes, number of children and/or number of members in a certain household, religiosity, and income), and we account for ANA using the same LC ANA approach as detailed in Chapter 6. Both approaches however did not improve the results nor the measures of fit and are therefore not reported in the results section.

⁴⁸ Also here we applied LC models, yet these models did not allow us to capture the unobserved heterogeneity.

4. Results

4.1. Descriptive characteristics of the milk producers

Table 7-2 describes the main characteristics of respondents and their respective households. The milk producers we interviewed were relatively young (40 years old) of which only a small majority is male (60%). Milk producers have large households, with 4 children on average. Milk producing households own on average 3 milking cows and 1-2 calves. Milk productivity is high (11 L/cow/day) compared to the average daily production of 1-2 L/cow in traditional smallholder systems [230]. Milk is sold daily mostly to FSPs (53%) followed by individual consumers (39%) and traders (8%). Traders are not too common in urban areas as they mainly operate in the rural-urban interface, transporting milk from rural to urban centres [469]. About 70% of the milk producers indicate to know the names of their milk buyers, suggesting that milk transactions tend to be largely personalized. General trust among milk producers is low but 40% of the producers do trust people of another religion to some extent.

Table 7-2: Main characteristics of the respondents and their households

Variable	Mean or proportion
Age of respondent (years)	41.37 (0.93)
Proportion female respondents	0.41
Religious background respondent (proportion)	
Orthodox	0.97
Muslim	0.01
Other	0.02
Household size	6.11 (0.15)
Number of children	4.29 (0.16)
Monthly household income (ETB)	18,162.53 (1539.89)
Milk selling frequency (proportion)	
Daily	0.99
Less than daily	0.01
Main buyer (proportion)	
Individual consumer	0.39
Trader	0.08
Milk shop	0.30
Other FSPs	0.23
Number of cows owned	3.22 (0.20)
Number of calves owned	1.64 (0.10)
Milk productivity (L/cow/day)	11.22 (0.28)
Proportion of respondents that know the name(s) of their milk buyer(s)	0.69
Stated general trust (proportion)	
Most people can be trusted	0.16
You need to be very careful	0.82
I don't know	0.02
Stated trust in people of another religion (proportion)	
Trust completely	0.12
Trust somewhat	0.27
Do not trust very much	0.06
Do not trust at all	0.08
I don't know	0.35

Note: When applicable, the standard errors are given within parentheses. Questions on whether respondents know the name(s) of their buyer(s) and trust questions were only asked after the choice experiment was conducted.

4.2. Does religious affiliation matter?

Producers' preferences for characteristics of milk buyers were estimated using different RP specifications (Table 7-3). We used different specifications to explore if there are preferences for a particular religious affiliation or gender (model 1), for a similar religious background or the same gender as the buyer (model 2) or for preference for either the same religious affiliation, same gender or both (model 3). As can be seen from Table 7-3, we did not find evidence of preferences for the religious affiliation or gender of the buyer.

The results of the models reveal that milk producers prefer traders over individual consumers and consumers over milk shops. However, when using interactions with current main buyers reported by the milk producers, the results show that the observed preference for consumers over milk shops only occurs for those producers that currently sell mostly to consumers (last column). The preference for traders is rather surprising, given that only 8% of the milk producers indicated that traders are currently their main buyers (Table 7-2). Looking descriptively at those milk producers that currently mainly sell to traders, we find that 14 out of these 21 producers have daily milk yields above the average of 11 L/cow as reported in Table 7-2. Moreover, 14 and 12 out of these 21 producers have at least three milking cows, and two calves respectively (again above the average in the sample). We also find that these producers are located more in the outer sub-cities, away from the inner sub-city of Kedamay Weyane. Producers that currently sell to traders are thus based more on the outer skirts of the city and have larger dairy herds and daily milk volumes. Probably we observe preference for traders over individual consumers because traders source larger volumes of milk at once. Moreover, data from traders in the Great Addis area suggest that traders often offer multiple services to their customers: continued purchase during fasting, equipment (especially feed), credit, training and milk pick-up. Continued purchase during fasting might be especially relevant within the Mekelle context to tie milk producers, given its almost exclusively Orthodox population. It is expected that as long as there is little wholesale demand for milk, which is particularly true in the city of Mekelle, traders will remain active and preferred intermediaries in the chain.

Furthermore, we observe that milk producers significantly prefer immediate payments, at the time of transaction, over delayed payments as well as high prices for their milk, irrespective of the religious affiliation of milk buyer candidates. The preference of immediate payment with unknown buyers (a deliberate choice within our experimental setting) is expected since delayed payment agreements usually arise when both seller and buyer have interacted repeatedly and thus have built up a trust relation. Since we hypothesize that delayed payments might make religion crucial when selecting among unknown milk buyers, we tested for the interaction of the attribute religion and payment terms. Yet, the effect was found to be insignificant.

Although we do not observe clear preferences for religious affiliation, we detect considerably preference heterogeneity around the attribute, suggested by the significant standard deviations around the estimated random parameters. We tried to uncover this by exploiting variation in respondent characteristics as well as patterns of ANA⁴⁹. However, both approaches did not allow us to explain the heterogeneity and improve our results.

⁴⁹ Strikingly we observe that the average inferred attendance rate to the attribute religion is very low among the milk producers, i.e. 6.5%, while for milk consumers this was found to be as high as 42.3% (see Section 4.2 Chapter 6).

Table 7-3: Results from the random parameter logit models

	Model 1	Model 2	Model 3	Interaction with current buyers
	β (SE)	β (SE)	β (SE)	β (SE)
Buyer type 1 (shop vs consumer)	-0.15* (0.09)	-0.18** (0.09)	-0.17* (0.09)	0.00 (0.11)
Buyer type 2 (trader vs consumer)	0.21*** (0.07)	0.21*** (0.07)	0.20*** (0.07)	0.28*** (0.09)
Payment (delayed vs immediate)	-0.96*** (0.17)	-0.90*** (0.17)	-1.02*** (0.17)	-0.99*** (0.18)
Price (ETB)	0.50*** (0.06)	0.52*** (0.06)	0.53*** (0.06)	0.50*** (0.06)
Religious affiliation (Muslim vs Christian)	-0.04 (0.06)	-	-	-0.03 (0.06)
Gender (female vs male)	0.06 (0.05)	-	-	0.07 (0.05)
Same religious affiliation vs different religious affiliation	-	0.01 (0.06)	-	-
Same gender vs different gender	-	0.00 (0.05)	-	-
Same religious affiliation vs different religious affiliation and gender	-	-	-0.11 (0.16)	-
Same gender vs different religious affiliation and gender	-	-	-0.12 (0.17)	-
Same religious affiliation and gender vs different religious affiliation and gender	-	-	0.23 (0.31)	-
Current buyer shop	-	-	-	-0.29 (0.27)
Current buyer trader	-	-	-	-0.07 (0.37)
Current buyer consumer	-	-	-	0.76*** (0.28)
	SD Rand. Pars (SE Rand. Pars)	SD Rand. Pars (SE Rand. Pars)	SD Rand. Pars (SE Rand. Pars)	SD Rand. Pars (SE Rand. Pars)
Buyer type 1 (shop vs consumer)	1.43*** (0.16)	1.44*** (0.16)	1.40*** (0.16)	1.40*** (0.16)
Buyer type 2 (trader vs consumer)	0.95*** (0.15)	0.93*** (0.15)	0.93*** (0.15)	0.90*** (0.16)
Payment (delayed vs immediate)	2.79*** (0.26)	2.71*** (0.25)	2.74*** (0.25)	2.80*** (0.27)
Religious affiliation (Muslim vs Christian)	0.56*** (0.17)	-	-	0.55*** (0.17)
Gender (female vs male)	0.24 (0.20)	-	-	0.26 (0.19)
Same religious affiliation vs different religious affiliation	-	0.52*** (0.17)	-	-
Same gender vs different gender	-	0.07 (0.24)	-	-
Same religious affiliation vs different religious affiliation and gender	-	-	0.32 (0.30)	-
Same gender vs different religious affiliation and gender	-	-	0.05 (0.24)	-
Same religious affiliation and gender vs different religious affiliation and gender	-	-	0.06 (0.37)	-
Log likelihood	-996.22	-998.538	-1000.3	-992.2
McFadden pseudo ρ^2	0.32	0.32	0.31	0.32
AIC	2014.4	2019.1	2030.5	2012.5
BIC	2071.5	2076.2	2098.0	2085.2

Note: ***, ** and * represent statistical significance at a probability of less than 1%, 5%, and 10% respectively.

5. Discussion

The available literature on discrimination in product markets usually takes a buyer perspective and studies discriminatory practices in markets where there is usually a large pool of potential sellers (online platforms). In this paper, we take a seller approach and aim at investigating whether producers discriminate among buyer groups. The studies that have taken this approach as well usually focus on price discriminations and find that sellers require minority buyers to pay higher product prices [363, 364]. Li et al. [369] on the other hand focused on offers made by sellers to different buyer groups and find that sellers were more likely to make offers to buyers with the same group identity.

Our study has the same objective as the one of Li et al. [369], i.e. investigating whether sellers (in our case milk producers) preferentially transact with buyers from the same religious group. In contrast to the study of Li et al. [369], we find that milk producers on average do not show dominant preferences for co-religious buyers. But, we observe significant preference heterogeneity around the attribute religious affiliation, suggesting that some producers have strong preferences for the religious affiliation of buyers while others have less or no preference. We were not able to statistically explain this heterogeneity by accounting for ANA and respondent characteristics in our models. Below we highlight several reasons that might explain our outcomes.

First, previous literature that focused on product markets has looked at cars, iPads, and other types of goods that can be easily stored. Milk on the other hand is highly perishable which might explain why some producers do not want to discriminate among potential buyers.

Second, we found in the previous chapter that an important sub-set of consumers self-select to co-religious sellers. If self-selection occurs, some producers might (perceive to) have less bargaining power when trying to sell their produce to potential buyers making some producers reluctant to turn down buyer candidates.

Third, religious bias could occur asymmetrical across buyers and sellers as List [368] found that buyer-side discrimination is more pronounced than seller-side discrimination.

Fourth, one could argue that SDB has led some respondents to not report their true preferences. Yet, we do not expect that this might be at stake in our experiment because of the following three reasons. First, we did not explicitly state the religious affiliation. We deliberately made use of both names and religious symbols to signal the religious background of potential milk buyer candidates. Second, we used a DCE that includes several other variables that are expected to affect producer choices, thereby making the attribute religious affiliation less salient. Third, despite these two actions, it is still possible that SDB occurs in our sample. To rule this out, we used a scaled heterogeneity model to compare choices made by respondents being confronted with names versus respondents

who saw religious symbols. This model showed that both groups of respondents did not make significantly different choices, implying that SDB is not at stake.

Fifth, it is possible that preference for religious affiliation varies in our sample because of the sales volume articulated in the experiment (i.e. one litre of milk). It is possible that the financial risk of not receiving the money for this milk, in case a buyer defaults, is not high enough for producers to invest a lot in screening the potential buyer profiles we constructed. Milk consumers on the other hand seemed to have a higher incentive to readily screen and search for reliable milk sellers given the common prevalence of milk adulteration, but also (and potentially more important) because of the health risk when buying bad quality milk contaminated with foodborne pathogens. Future studies should repeat this experiment and include larger transaction volumes as it is likely that discriminatory practices will pop up more easily when the transaction volumes involved are larger thereby increasing the financial risk for producers. This is also what we would expect from previous studies that found evidence of discriminatory practices in the labour and rental housing market, where the costs that both employers and landlords can incur are high if they do not properly select among the potential candidates.

Sixth, the lack of clear preferences for religion among all producers could also be explained by the dominant preference we observe in our sample for immediate payment when producers are confronted with unknown milk buyers. Preference for immediate payment cancels out the need to assess whether potential buyers are trustworthy. Also when interacting the attribute religious affiliation with payment terms, we did not find a significant effect. Potentially here again the low sales volume articulated in the experiment could play a role. When producers are confronted with two buyers with one of the buyers purchasing small quantities of milk with immediate payment versus another buyer purchasing larger volumes of milk but with delayed payment, it might nudge producers more to consider the second buyer and therefore it is more likely that in such a situation producers will consider the religious affiliation of buyers important. Hence, future experiments would benefit from including sales volumes as an attribute in the experiment to explore these hypotheses.

Seventh, it is possible we do not find an overall significant preference for the religious affiliation of milk buyers, since we performed this study in an almost exclusive Christian setting. Therefore, most transactions already occur between Christian producers and Christian buyers making producers in our sample less sensitive for the religious attribute. When one would repeat this experiment in a more mixed setting, it is likely that producers will more readily screen the religious affiliation of potential milk buyers. Further research could thus benefit from repeating this experiment in different religious settings in Ethiopia to verify this hypothesis, but also to investigate whether Muslim producers show preferences for the religious affiliation of milk buyers as our current sample had too few observations on Muslim producers to explore this. Alternatively, it is likely that producers in our

sample do not want to discriminate against religious out-group members because these out-group members might be important buyers during fasting periods, especially in highly dominated Orthodox settings. Applying this to our setting, some Christian producers might not want to discriminate against Muslim buyers, because they could be potentially important buyers during fasting periods. However, we also found in Chapter 3 that the likelihood of Muslim households to consume milk significantly reduces during Orthodox fasting, which might downplay this reasoning to some extent. Future studies could also benefit from focusing on larger sample sizes so as to better assure that the sampled respondents are accurately representing the population. Moreover, future studies could benefit from incentivized decisions, where respondents' decisions are coupled with actual payments, so that the decisions made are a more realistic representation of the respondents' true underlying preferences.

In general, our findings do not refute what is expected from theory (i.e. homophily and discriminatory practices in the light of informational asymmetries). Our findings should be seen as a lower estimate and future studies are needed to further investigate the presence of religious preferences among milk producers. The actual impact of religion on real-world transaction decisions is also expected to be bigger especially because many transactions happen within social networks that often are or have been established by sharing religious ties.

6. Conclusion

In this chapter, we singled out whether religion impacts milk transaction flows. Taking a milk producer perspective, we tried to uncover what buyer characteristics are important for producers if they want to engage in milk transactions. We investigated this in a controlled environment using a DCE. We find that on average, milk producers do not reveal significant preferences for co-religious buyers. Yet, we observe significant preference heterogeneity around this attribute. This implies that some producers have strong preferences for the religious affiliation of milk buyers, while others have less or no preference.

In general, our findings do not refute what is expected from theory (i.e. homophily and discriminatory practices in the light of informational asymmetries). The results from our experiment should be seen as a lower estimate since the choice experiment investigated preferences for milk transactions that involve one litre of milk. Future studies are needed to analyse our findings in greater depth. These studies would benefit from (1) including sales volumes as an attribute in the experiment to see whether religious preferences become more pronounced when larger volumes of milk are involved in the transactions and (2) from repeating this experiment in different religious settings where religious preferences are potentially more at stake.

CHAPTER 8

Conclusion

1. Overall summary

In this dissertation, we examined how the Ethiopian milk system has evolved within a diverse and long-standing religious context. Accounting for the impact of socio-cultural factors (of which religion is one) on ASF demand and supply patterns is pivotal and therefore deserves more attention from policy makers and scholars. We unpacked our general objective in three research questions, that each tackle a specific element within the milk system: i.e. milk consumption, milk production and output use, and milk transactions. This dissertation is innovative for two reasons: (1) because of the topic (religion and the food economy, the focus on Orthodox Christians in a low-income setting, and the focus on milk and the larger religious community – so not only Orthodox households) and (2) because of the methodological approach, using diverse data sets, study methods, and econometric models. Both primary and secondary data were incorporated that were either nationally representative or geographically confined (Great Addis and Mekelle city), covering either rural and (peri-)urban households or only urban households, and focusing on both milk consuming and producing households or only one of both. Three of the five chapters used observational studies with surveys, while two other chapters incorporated controlled experiments. Data were analysed using linear probability models, linear regression models, cluster analysis, and choice modelling.

In this dissertation, we analyse the impact of religion thoroughly and in an in-depth manner, so as to ‘take’ the devil ‘out’ of the detail and ‘put’ God ‘in’ the detail⁵⁰. We make religion’s influences visible in two ways by quantifying the impact of religious fasting rituals on milk consumption, production, and output use, but also by detailing if producers and consumers consider the religious affiliation of potential milk buyers and suppliers respectively. Although the findings of this dissertation are specific to the studied research localities and thus cannot be extrapolated as such, we gained a better understanding of how religion affects the Ethiopian milk system. This, not only helps us to address voids in the academic literature, but also to formulate more effective interventions in the country that aim at developing the dairy sector, and improving food security and nutritional outcomes.

We also gained more insight in the urban milk system, due to fieldwork conducted with urban milk producers, milk shops, and consumers in Mekelle city. Again, this helps policy makers to better support urban milk production systems as well as to help establish (a gender-sensitive) urban dairy sector. Moreover, our exploratory findings enrich academic literature that has insufficiently detailed urban milk, but also other ASF systems, in developing nations.

⁵⁰ ‘God is in the detail’ is an idiom that conveys the idea that whatever one does, should be done thoroughly as details are important.

2. Synthesis of research findings

In what follows, we will synthesize our answers to the research questions.

To investigate how religion influences milk consumption, we detailed the impact of the presence of a religious fasting period (Lent) on household milk intake. Using nationally representative data from the LSMS programme, we find that fasting impacts milk intake and sourcing strategies of consumed milk, and that these effects are not limited to the Orthodox community. The presence of a long fasting period reduces average probability of a household to consume milk, irrespective of which religious group a household adheres to, but it is especially so among Orthodox and Muslim households. This impact is larger in dominantly Orthodox settings. Furthermore, we observe that for those households consuming milk, Orthodox fasting negatively affects milk purchase intention among all households in dominantly Orthodox localities. This suggests that, due to repeating fasting spells, local dairy market development in dominantly Orthodox settings has been hampered. It seems that the practice of fasting thus affects milk consumption in two ways. First, consumption is directly affected by fasting as Orthodox consumers are not allowed to drink milk or eat milk products during fasting periods. Second, fasting impacts the availability of dairy produce, especially in dominantly Orthodox areas, where less milk can be acquired from the markets during fasting which reduces milk intake among non-Orthodox households.

Since fasting periods are spread throughout the year, with long fasting spells in February-March (55 days), July (10-40 days), August (16 days), and December-January (40 days), fasting causes significant dairy demand seasonality, which adversely affects milk production systems, an effect we detailed for two dominantly Orthodox localities. Using data from 870 milk producing households in the commercially-oriented Great Addis milk shed, we study the impact of the presence of a long fasting season on milk production, marketing, and consumption. We find that producers adopt different strategies to cope with long Orthodox fasting seasons, and that these strategies vary with farmer's market access, which we proxy by remoteness. We find that remote farmers mainly rely on reducing the production of milk by their dairy herd during long fasting periods. The milk that is still produced by these households is processed or channelled to their young children. As a result, these households sell and consume significantly smaller quantities of liquid milk during fasting periods. The intake of milk by their youngest children is not affected by the presence of a long fasting period. Liquid milk sale opportunities of non-remote farmers on the other hand are significantly less affected by long fasting periods. But we observe considerable heterogeneity among these farmers in their ability to maintain milk sales during fasting seasons. Some of these farmers seemingly benefit from being better connected to buyers that continue purchasing milk during fasting periods. As a result, non-remote farmers, on average, do not reduce the total production of milk at their farms significantly. Yet, to compensate for (some) forgone market opportunities during fasting, these farmers process a

significantly larger share of the produced milk during fasting and they feed significantly more milk to their young children. As opposite to remote farmers, consumption volumes of liquid and processed milk in non-remote households are not affected by long fasting seasons.

Intrigued by these findings, we wondered how milk production systems have evolved in settings where almost exclusively Orthodox Christians reside (over 95%), i.e. in the Mekelle milk shed, an area that has barely been studied. We interviewed milk producing households within the city of Mekelle, where the milk market is mostly developed. Aligning milk production with fasting periods is not widespread in the city, and if practiced, only at best partially solves the demand-supply mismatch. All the dairy farmers we interviewed, were Orthodox Christians and less than 5% of the milk they produce is consumed within the households (by children and elderly mostly) both within and outside fasting periods. These households thus mainly rely on milk processing and continued milk sales to overcome fasting events, yet significant variability exists in the importance of these adaptation strategies among farms. We therefore clustered farms in five groups, that differed on three important dimensions: input efficiency, market integration and resilience towards demand seasonality. Here we summarize the main findings to illustrate how farms have adjusted to periods of reduced milk demand.

Farmers from only three out of the five milk producing clusters we found, manage to sell about half of their milk output during Orthodox fasting, with one group selling up to 70% of the produced milk. This latter group, which we named established, output-efficient farms, shows to be best integrated in the market with stable and remunerative milk prices regardless of fasting periods. Members from another cluster, processing farms, completely rely on milk processing to overcome fasting events, with on average 96% of the produced milk being processed. Yet another group of farmers, the young male entrepreneurs, hardly consume, sell nor process milk during fasting. Produced milk is thus largely spoiled in these farms during fasting events. Among all groups, we see that farmers barely process milk during non-fasting periods. Traditional milk processing carried out at household level is labour-intensive and time-consuming. Furthermore, the conversion of milk is inefficient. This limits the opportunity of value addition opportunity for processing significantly. One could thus argue that traditional processing in Ethiopia is so widespread because of Orthodox fasting rituals that are practiced by a majority of the population⁵¹. Only during Orthodox fasting, when milk demand drops, processing of milk into butter and other processed milk products might be interesting for urban farmers as it increases the shelf life of milk and thus allows to bridge the fasting period. Furthermore, in Mekelle city, we observed that the processed milk products are hardly sold, but mostly consumed

⁵¹ Of course, in more remote areas, processing is widely practiced to mitigate for poorly functioning or absent milk markets [470].

by the households themselves. Only farmers of two clusters sell excess butter. This all suggests that processing seems to be mainly consumption stabilizing rather than a sales stabilizing strategy.

Fasting rituals undeniably impact both milk consumption and production as shown above. We showed how Orthodox fasting rituals create considerable market inefficiencies especially in dominantly Orthodox settings. Particularly Muslim households seem to be affected in these settings, more than Protestant households. As markets dissolve in dominantly Orthodox settings, we would expect that both milk intake of both Protestant and Muslim households is equally affected by fasting. Yet, this is not what we observe. A tentative explanation for these findings could be that the spill-over of social norms (in this case respecting the Orthodox fasting) is stronger for non-Christian groups, in our case Muslims. Protestants, who belong to the broad class of Christianity, show higher interpersonal similarity with the Orthodox community and thus the social distance between both groups is smaller compared to the distance between Orthodox Christians and Muslims. A vast body of literature on in- and out-group interactions has assessed differential attitude/behaviour/treatment of one group vis-à-vis the other group. These studies implicitly consider the out-group to be homogeneously composed. We argue that considerable heterogeneity exists within the out-group, especially in terms of social distance and literature has shown that social distance affects judgments and behaviour towards others. In our research, we purposely investigate how the practice of fasting within the Orthodox community, which in this case could be considered the in-group, affects three different out-groups (i.e. Protestants, Muslims, and other religions). Yet, the limitations of our datasets do not allow us to investigate the social norm channel in further detail.

Besides the spilling over of social norms, it is also possible that market inefficiencies arise from coordination problems between different religious groups, which affects the willingness to trade among each other. We thus investigated whether the religious affiliation of potential trading partners affect trading preferences of both milk producers and milk consumers. Particularly, we have studied if sharing religious ties, by being member of the same religious group, facilitates or inhibits milk exchange.

When evaluating trading preferences among milk consumers, we observe clear preferences for milk prices, proximity of milk suppliers and type of milk suppliers, while the religious affiliation of milk suppliers is no decisive factor, on average, when consumers choose from whom to buy milk. Yet, we observe low attendance rates for this attribute, which could explain why we do not find dominant preferences for this attribute. Since liquid milk is typically traded in spot market transactions and almost daily purchases of small quantities, consumers can easily shift to other suppliers if they are not satisfied. This flexibility could explain why not all consumers pay attention to the religious background of suppliers, but rather focus on characteristics they value more, which seem to be the type of supplier, proximity of the supplier, and milk prices. When we accounted for attribute non-

attendance, we observe that part of the consumers does take religion into account when deciding to engage in hypothetical milk transactions and they tend to self-select to co-religious suppliers. These consumers are willing to pay more or walk further to find a co-religious supplier but this extra price and effort is smaller than what consumers are willing to pay more or walk further to buy milk from milk producing households. For milk producers, we find that, on average, they do not reveal significant preferences for co-religious buyers. Yet, we observe significant preference heterogeneity around this attribute. This implies that some producers have strong preferences for the religious affiliation of milk buyers, while others have less or no preference. More research is needed to repeat our experiment and validate our findings, but overall we seem to find evidence that religious segmentation might be at stake in the Ethiopian milk market.

Take home message box**How does religion influence milk consumption?**

Orthodox fasting reduces milk intake at household level not only among practicing Orthodox households but also among non-Orthodox households in dominantly Orthodox settings. In milk producing households living in the dominantly Orthodox Great Addis milk shed, young children seem to benefit from Orthodox fasting who get excess milk allocated.

How does religion affect milk production and output use?

Milk producing households in dominantly Orthodox settings have adapted to periods of reduced milk demand by (1) aligning milk production at the farm with fasting periods, (2) by increasingly channelling produced milk to their youngest children, and (3) by expanding their milk processing activities. The importance of each of these strategies depend on market accessibility and the density of Orthodox Christians.

Does religion interfere with milk transactions?

Not only do Orthodox fasting periods affect milk consumption, production, and output use, we find evidence that religion also impacts milk transactions. Our findings point to religious segmentation in the Ethiopian milk market. The impact is most outspoken for milk consumers, where we find that a large group of consumers consider the religious affiliation of potential milk sellers when deciding from whom to buy milk. These consumers (in)consciously self-select to co-religious suppliers. Milk producers on the other hand do not directly discriminate against the religious affiliation of potential buyers on average. Yet, we find significant preference heterogeneity around this attribute, which suggests that some producers do show strong preferences for the religious affiliation of potential buyers, while others have less or no preference. More research is needed to validate our findings.

3. Contributions

This dissertation contributes to literature in various ways. We cast light on the role of religion in food system development, a research area that has been vastly understudied. We study this in Ethiopia, a low-income country, and focus on a large, yet neglected, group of Orthodox Christians. This opposes previous studies that focused merely on high-income countries and Islamic beliefs and practices (notably Ramadan). This dissertation takes a comprehensive approach, and focuses on three elements of the milk system, that are intertwined and can therefore not be studied separately: consumption, production, and transactions. The focus on a non-conventional product (milk) is also opposite to earlier investigations that have targeted meat and substances. Furthermore, we detail the wider societal impact of the Orthodox religion, by focusing also on non-Orthodox households.

For the first two elements, milk consumption and production, we focus on religious rituals, (fasting practices) and how these cause significant dairy demand seasonality that impacts dairy production. We are the first to quantify these effects in detail in the context of Ethiopia. We do so at several levels: (1) at the national level, (2) within the most developed dairy hub of Ethiopia (the Great Addis milk shed) hosting an Orthodox majority, and (3) for an almost exclusive Orthodox and urban setting (Mekelle city). Including this urban perspective is new and a black box within academic literature. This dissertation thus allows to get a better understanding of the divergent ways in which dairy producers manage their production systems within a city, and how markets have developed in these areas.

Additionally, we investigate how religion, as a part of one's identity, interferes with milk transaction preferences of both producers and consumers. We study this using choice experiments applied to individuals rather than the more commonly used way of assessing preferences among products, services, or programmes – an innovative approach. The prevalence of market exchange preferences based on shared membership within a social group and potential market segmentation that might result from such preferences, has received little scholarly attention so far, which is another gap we address.

Furthermore, we are the first that tried to gain insight in exact adherence to fasting practices in Ethiopia as well as the intensity of belief (i.e. religiosity). We have studied exact adherence and religiosity in two different settings, yet both hosting an Orthodox majority: the Great Addis area and Mekelle city. Detailing fasting adherence at household member level in the Addis area revealed that effective adherence is lower than what has been estimated in literature and varies significantly along the different fasting periods. Furthermore, beliefs about the involvement of children in fasting practices are less strict than what has been observed in previous studies and imposed by the Orthodox Church. Both trends could suggest that individuals have some flexibility to circumvent the formal rules of fasting as laid out by the Orthodox doctrine. Yet, there is still a minority group that

enforces the participation of all, including children, pregnant and lactating women, elderly or severely ill people, who are all, in principle, exempt from fasting. Adhering to Orthodox fasting events might thus be a choice to some, while it is a must to others. Strict adherence to fasting habits can be the result of strong internalization and/or strong external enforcement. The extent of engagement in religious practices is thus not only individual-specific, but also context-specific. The individual- and context-specificity can be translated in attitudes and social norms respectively [471]. While attitudes are internally motivated judgements (e.g. “I think fasting is crucial be a good Orthodox Christian”), social norms are beliefs about what other people do and approve (e.g. “People around me fast and find it important that others do so also”). Attitudes and social norms might not be aligned, and the resulting behaviour of fasting adherence is thus a complex interaction between attitudes and prevailing social norms. The degree of fasting adherence is thus context-specific and might vary within the country. Therefore, studies should adopt a case-based approach when evaluating the impact of fasting in different localities, as did this dissertation.

4. Implications

In what follows, we will conceptualize the implications of our research findings. More specifically, we will use the demand and supply framework to sketch the effect of Orthodox fasting on the market of liquid milk in three different settings we studied: i.e. rural dominantly Orthodox Great Addis, urban dominantly Orthodox Great Addis and urban dominantly Orthodox Mekelle. As mentioned above, our results show that the impact of fasting is highly context specific, especially because milk markets are highly localized in nature in the country.

Demand and supply models are useful to explain prices and quantities traded in market exchanges. The demand curve visualizes the highest price consumers are willing to pay for a certain quantity and the highest quantity consumers are willing and able to buy at a given price. Supply curves represent the lowest price producers are willing to accept for a certain quantity and the highest quantity producers are willing to provide at a given price. This price should at least cover the cost of producing an additional unit of milk. The intersection of the demand and supply curve determine the equilibrium price and quantity. At the same time, demand and supply curves may shift due to changes in consumption, production, and market conditions. Of interest in our study is obviously the impacts of shift on the market equilibrium induced by fasting. In our figures, P_{NF} and Q_{NF} denote the equilibrium price and quantity of liquid milk in non-fasting periods, while equilibrium price and quantity change to P_F and Q_F during fasting periods.

Price elasticity of demand and supply varies significantly in our three study areas (Figure 8-1). Demand is rather inelastic in rural areas as rural households who consume milk predominantly source this milk from own production as shown by Abegaz et al. [8]. Therefore, these households will be less sensitive to changes in market prices for milk. Demand is more elastic in urban areas given the greater dependence on the market to satisfy household milk needs [8]. Milk demand in urban Mekelle is more inelastic as compared to milk demand in urban Great Addis, given the larger concentration of Orthodox Christians in Mekelle city. In Chapter 3, we observed that the more dominant the Orthodox community is in a particular setting, the less likely households are to consume milk and the less likely they are to source consumed milk from the market. Supply on the other hand, is assumed to be very elastic in urban Great Addis, as we observed that prices changes seem not to affect the milk sales volumes of non-remote farmers significantly (Chapter 4). Aggregate supply can easily adjust because of the numerous small-scale specialized production systems in this area. Supply in Mekelle is less elastic given the smaller number of specialized production systems in the city of Mekelle. Supply in rural Great Addis on the other is more inelastic as compared to supply in Mekelle, because of the greater importance of home production in rural areas [8].

The impact of fasting is differential across our three study areas, as we observed throughout the different chapters (Figure 8-1). First, the downward shift in demand for liquid milk (from D_{NF} to D_F) is expected to be the largest in rural Great Addis. We found in Chapter 4 that the average intake of liquid milk in remote producing households in the Great Addis milk shed drops significantly during fasting by nearly 50%. We expect the aggregate demand drop to be even larger, since there are also many rural non-producing (Orthodox) households who reduce their intake during fasting. Demand shifts in urban areas are expected to be smaller. As such we found that self-reported adherence to fasting practices is more strict among remote households as compared to non-remote households (Supplementary material Chapter 4). While most of urban households are Orthodox Christian, they might still want to purchase milk for their young children who are exempt from fasting. Furthermore, in urban settings, milk buyers are more diverse and we have found in Chapter 4 that retailers and processors, who are mostly present in urbanized settings in Ethiopia, are the most important buyers who keep on purchasing milk from non-remote farmers during fasting periods. Urban milk buyers are thus more likely to keep on sourcing milk from the market as compared to rural milk buyers during fasting periods, explaining the smaller shift in demand in urban areas. Yet, in Mekelle city, we expect to observe a larger drop in demand during fasting given the higher concentration of Orthodox Christian households and because fewer retailers and processors are present in the city as compared to the well-established market of Addis Ababa.

Likewise, fasting also affects the supply of liquid milk. Our findings in Chapter 4 showed that remote milk producing households cut down their milk production volumes by 60% during fasting periods, explaining the large drop in supply (from S_{NF} to S_F) in this area. Producers in Mekelle city and urban Great Addis on the other hand align their milk production output much less with fasting periods as observed in Chapter 5 and 4 respectively. Urban producers in Great Addis did not significantly reduce their milk sales volumes (Chapter 4) while producers in Mekelle increasingly process milk to more storable products during fasting (see Chapter 5) because market opportunities for milk are more reduced in Mekelle city during fasting as compared to urban Great Addis. This explains the larger shift of supply observed in Mekelle as compared to urban Great Addis.

The impact of fasting on the market equilibria in our three study areas are as expected. Price swings of liquid milk are the largest in Mekelle and have been shown to drop by about 25% (Chapter 5). Prices in remote and non-remote areas of Great Addis decrease much less (by 6% and 2% respectively (Chapter 4)). Likewise, the fluctuation in the volume of liquid milk traded between fasting and non-fasting periods is larger in rural areas as compared to urban areas, and larger in Mekelle city than urban Great Addis – the reason for this latter observation being the larger drop both in demand and supply of liquid milk in Mekelle.

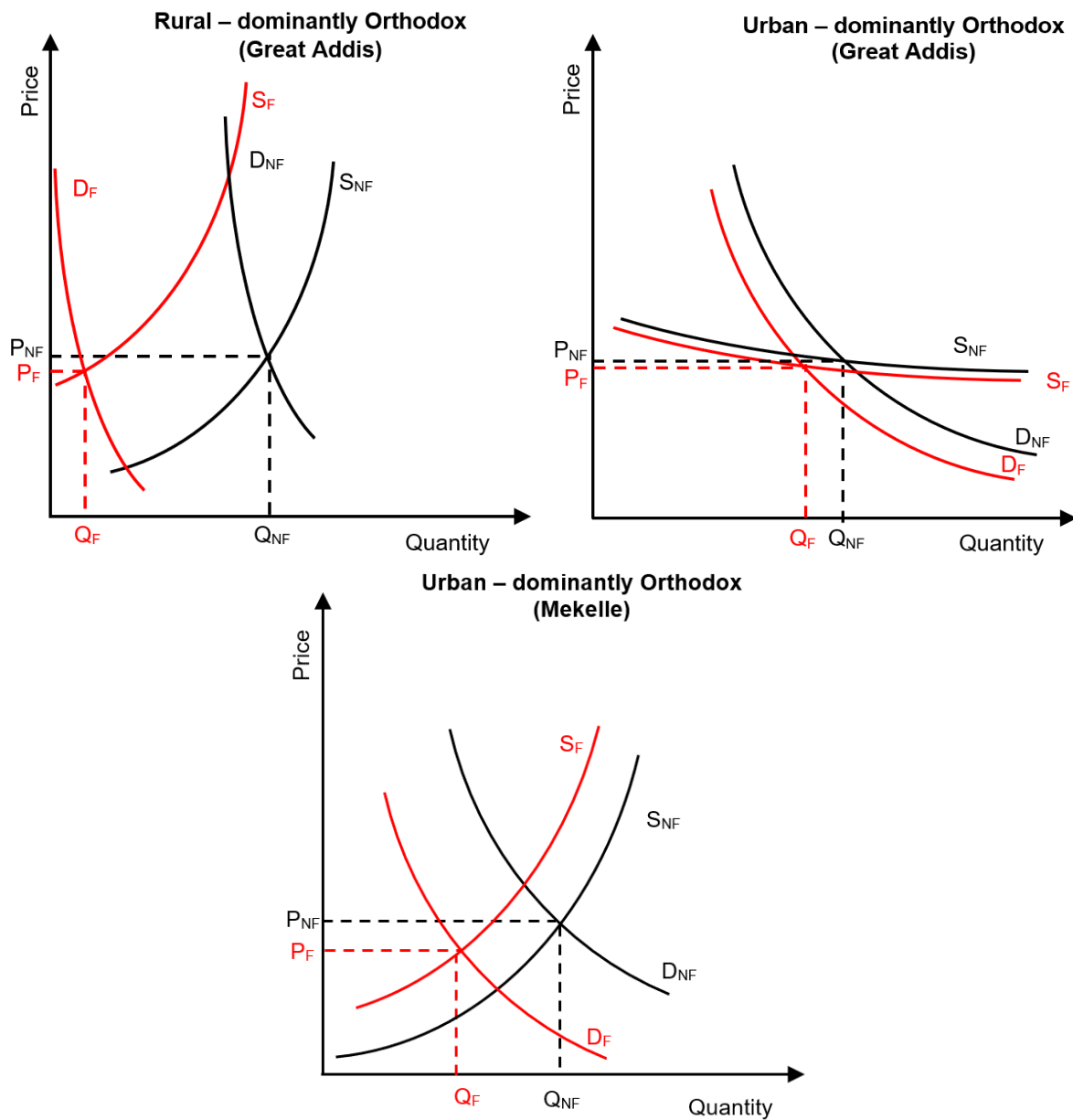


Figure 8-1: Illustrating the impact of fasting on the market of liquid milk in the three study areas of this dissertation using the demand and supply framework

5. Recommendations

5.1. How to limit the impact of Orthodox fasting on the Ethiopian milk system?

From the demand and supply framework above, we observe that fasting impacts the volumes of milk being marketed, mostly by its impact on the demand of milk. The limited impact of fasting on milk prices is because the downward shifts in demand are compensated for by a reduction in the supply of liquid milk. Fasting thus reduces the availability of liquid milk in the market. One could argue that prices of liquid milk are kept artificially high during fasting seasons, while price drops would be beneficial to low-income households. Yet, producers, but also other supply chain actors, try to limit the impact of fasting on their revenues. It seems that farmers reduce the amount of milk being marketed as a result of the anticipated drop in milk demand observed during fasting periods. Only in urban Great Addis we found that producers close to the market of Addis Ababa are not significantly reducing milk sales because (mostly) large buyers (retailers and processors) keep sourcing milk during fasting periods. van der Valk and Tessema [243] report anecdotal evidence that some of these buyers continue to source milk during fasting to maintain buyer-seller relationships, even if that entails that these buyers have to throw away the milk.

Our results invite the policy question of how to mitigate the impact of Orthodox fasting on the Ethiopian milk system. We will propose soft measures, in the belief that hard measures (i.e. prohibition of religious fasting rituals) are not feasible nor desirable. Crucial will be to either reduce the demand shifts observed during fasting and/or deal better with demand fluctuations. Keeping up milk demand during fasting periods can be achieved in various ways and we will propose a number of interventions that ideally are undertaken simultaneously: nutrition awareness creation, school milk programmes, and market integration. Important to note here is that these proposed interventions will raise overall demand and not just demand during fasting periods. Enhancing and increasing off-farm processing facilities, trainings on (artificially) synchronized breeding as well as stimulating the formation of farmer groups on the other hand could help producers to deal better with demand fluctuations.

Nutritional awareness creation

First, it will be important to increase milk consumption of young children as well as pregnant and lactating women during fasting through nutritional awareness creation. Although both are officially exempt from fasting observance, social norms still force these groups to engage in fasting practices with negative repercussions for nutritional and health outcomes. Raising awareness about the nutritional benefits of including milk regularly in children's, and pregnant and lactating women's diets among the practicing Orthodox households will be crucial, but ineffective without a strong involvement of religious institutions and leaders in nutritional programmes [214]. In 2016, the United States Agency for International Development together with the Ethiopian Orthodox Church,

developed a sermon guide that clarifies the religious guidelines around fasting practices for children, and pregnant and lactating women, and emphasized the need for continued milk consumption among these groups during Orthodox fasting seasons [472]. Such initiatives are crucial to alter strong societal norms about fasting observance. Nutritional awareness creation has the potential to increase milk consumption during fasting seasons in Orthodox households by vulnerable groups who are exempt from fasting – not only children, but also pregnant/lactating women, and elderly. It is also an important strategy to increase the intake of milk among non-fasting households during fasting periods. Yet, such awareness creation will not be sufficient as long as milk remains a luxury product. Therefore, further investments are needed to intensify milk production systems and increase milk productivity so that more milk becomes available at lower prices. Only when prices of milk lower, milk will become more accessible to household members that are currently not prioritized when it comes to milk intake. If prices lower, it will be important to improve the milk market functioning so that producer incomes can be guaranteed.

Guaranteed market outlets during fasting

Second, establishing guaranteed market outlets that ensure continued demand for milk even during fasting periods is called for. We disentangle two potential markets: school milk programmes and increasingly channelling milk to areas where fewer Orthodox Christians reside. Penetrating markets where the effect of fasting is less present, could be an important strategy. Preferably, these markets are located within the country so as to further integrate the national milk market. But market integration needs investment in transportation and distribution systems (e.g. cooled transport, the establishment of collection centres etc.). The government could play a role here by providing (better) public infrastructure (e.g. roads). More guaranteed market outlets would reduce the need to align milk production with fasting periods. Yet, it will be important to keep in mind that milk producing households now allocate excess milk to children due to lack of marketing opportunities during fasting. It is unclear if these producing households would still allocate more milk to their children during fasting periods, if there would be alternative market outlets available. To avoid such a practice, nutritional education is recommended.

Since children below the age of seven are exempt from fasting, school milk programmes could be very effective not only to lower the demand-supply mismatch during Orthodox fasting, but also to improve food security and adequate nutrition among children. In Ethiopia, annual School Milk Days are celebrated since 2000, and subsidized by the United States Agency for International Development and the U.S. Feed the Future Initiative for food security and nutrition. The aim of these School Milk Days is to raise awareness and knowledge about the importance of milk for nutrition among children, their parents, and teachers, and to encourage government and school officials to develop school milk programmes across Ethiopia [473]. Public school milk programmes are as of

yet not well established in Ethiopia. Some initiatives exist and are established under aid-funded project assistance, but their geographical scope is rather limited. While such assistance is very useful, it is finite and difficult to sustain. To make such programmes sustainable, they should be subsidized by the industry, the government, or both. In many countries, school milk programmes have been shown to promote the growth of the national dairy sector [474].

Investing in off-farm processing facilities

Third, besides creating alternative market outlets, increased diversification of liquid milk into milk products so as to structurally raise the shelf life of milk, will also be important to bridge slack periods in milk demand both in the informal and formal chain. Public and private investments to support and expand off-farm processing facilities would help farmers to continue selling milk during fasting spells, without requiring these farmers to specialize and invest in home-processing activities which are time- and input-inefficient and do not create substantial value addition [13, 236]. This need has been recognized in the Livestock Master Plan of the Ethiopian government of 2015. What is important here is that processing should be seen as a way to overcome periods of reduced milk demand, rather than only as a tool to achieve price differentiation so as to avoid that prices for processed milk products do not become too high, making these products less affordable. Demand for processed milk products is high in Ethiopia and processed milk products account for 52.2 percent of the total consumption of dairy products [8]. While increased processing might help producers to overcome periods of slack demand, processors themselves are also confronted with demand seasonality. Therefore, nutritional awareness creation is needed to increase consumption of processed milk both during and outside fasting periods, as well as market integration to transport the milk to areas where fasting is less prevalent. Further investments in proper storage and conservation facilities are also needed so that milk products can be stored at low costs over longer time periods without quality reduction.

Aiming at gradually modernizing the informal milk system will be crucial, not solely because of the employment opportunities it creates, but also because this system includes many women, small-scale producers and operators in Ethiopia. Expanding the processing infrastructure will contribute to a continued demand of liquid milk during fasting periods, while simultaneously lowering the prices for liquid milk during fasting periods, making it more accessible and affordable for lower-income households. To date, processing is largely small-scale using traditional methods that are time- and output inefficient. Traditionally processed milk products are usually intended for home consumption and only excess products, mainly butter, end up in the market. Home processing could be reduced with the expansion of small-scale processing units that efficiently bulk milk from individual farmers. Moreover, such units could try to create a branded assortment of traditional products for local

markets. Upgrading of traditional processing techniques will be crucial to improve output efficiency, hygiene, quality, and marketing potential [243].

Besides these small-scale processing units, formal processing could also be stimulated. About 40 formal and industrial-scale milk processors are now operating in the country (yet often below their optimal capacity), and these are located principally around Addis Ababa. The Ethiopian government should thus promote and incentivize private investors to expand this processing infrastructure, one of their ambition as laid out in the Livestock Master Plan of 2015 [266]. It will be important that these industrial-scale processors focus on supplying milk products that take into account consumer preferences. Research has shown that consumers, even when their income increases, still prefer liquid and processed milk offered by informal supply chains over those that are sold in modern retail outlets because of the perceived better quality (freshness and better flavour particularly) [257]. Another important aspect will be to keep prices for milk low, as milk is still a luxury product that cannot be consumed regularly. Milk products marketed in the formal value chain are still more expensive compared to those available in traditional market outlets (see Chapter 2). The Ethiopian government is making large investments to raise productivity and milk output in the country, which will help to push down prices for milk [266]. Yet, further actions will be needed to reduce prices, increase the competitiveness of the formal dairy sector, but also solve the inefficient logistics that link producers and processors. Furthermore, another problem industrial-scale processors face is the lack of long-term commitment from milk producers. In periods of abundant demand and milk shortage, e.g. during the religious feast of Easter in April-May, producers can choose to whom they sell their milk to, and anecdotal evidence has shown that producers default on agreements made with milk processors and pursue higher milk prices. On the contrary, when demand is low and when there is an oversupply of milk, especially during Orthodox fasting periods, power dynamics shift and processors can decide from whom to buy milk and farmers report that processors stop sourcing milk during fasting or reject milk because of milk quality reasons [243]. This cyclical power dynamic arises as contracts are rarely enforceable. Therefore, further efforts are needed to make these contracts enforceable but more interestingly is that producers and processors make better contracts with processors offering continued purchase of milk (even at lower prices to compensate for the extra costs processors incur to store dairy products during the fasting season), while farmers in return ensure a stable supply of milk. To further reduce supply seasonality, farmer groups could play a key role in assembling larger and more stable volumes of milk. Furthermore, processors could try to tie producers by providing extra benefits, e.g. by delivering (improved) dairy inputs, a common practice now among traders in rural areas. Such a strategy could increase vertical collaboration in the chain, which is now almost completely lacking [243].

Strengthening individual farmers

The interventions summarized above (nutritional awareness creation, school milk programmes, market integration and enhancing and increasing off-farm processing facilities) will take time to help farmers cope better with demand swings observed during fasting periods. Therefore, also producing households should be supported to help them cope better with fasting periods. As such, trainings on (artificially) synchronized breeding could be an important strategy, especially during the Lent fast, which coincides with the dry season in Ethiopia. Furthermore, distributing improved processing technologies so as to increase the efficiency of home-processing of milk could also be a good strategy. Further stimulating the formation of farmer groups could also be an effective way to reduce transaction costs and facilitate market integration of farmers both during and outside fasting periods. Furthermore, these groups could jointly invest in small-scale processing facilities and product differentiation. Making farmers more resilient towards demand seasonality will incentivize them to further invest in their dairy farm and structurally raise milk productivity and input efficiency. This can also be concluded from our findings in Chapter 5⁵².

⁵² In Chapter 5, we found that farmers in cluster 5, which we termed the established output-input-efficient farms, are fairly good integrating in the market and have a diverse buyer pool which allows them to keep on selling part of their milk production during fasting while simultaneously fetching relatively good prices for their milk. This good market integration could explain why these farmers are investing in their farms and are trying to increase their input efficiency (by feeding more diverse diets to their herd, using hay instead of crop residues and adding salt to the diet).

5.2. Religious ties and urban agriculture

Besides studying the impact of Orthodox fasting on the Ethiopian milk system, we also investigated how religion interferes with milk market transactions. We find evidence that religious segmentation might be at stake in the Ethiopian milk market. We anticipate that with the expansion of the formal value chain, that involves an increasing number of actors, anonymized trade will prevail much more, reducing the importance of shared group membership for milk market exchange. Furthermore, if quality standards are enforced more using formal mechanisms that consumers can trust, consumers will tend to resort less to arm-length trade with co-religious milk suppliers. Moreover, as the law of contract is likely to be enforced in the future, this also reduces the need for milk producers to readily screen for reliable milk buyers.

Yet, with increasing inter-religious tensions between Muslims and Christians in the country, it is possible that consumer boycotts or buycotts might arise, which could lead to effective and strong market segmentations [223]. Religion-driven boy- or buycotts can be highly persistent and damaging, especially in contexts where people are highly religious and when these campaigns are supported by religious leaders [414, 415]. Such boy- or buycotts can easily spread throughout the country, because of the support of fellow religious group members [416]. Examples of religiously inspired boycotts are the boycott against import of Danish products by several Muslim dominated countries (among which Saudi Arabia, Turkey, United Arab Emirates) in the aftermath of a series of cartoons published by a Danish newspaper in 2005 that negatively depicted the Islamic prophet Muhammed [417] and the Buddhists' boycott against Muslim businesses in Myanmar because of religious tensions between both groups [418]. In Ethiopia, religious boy- or buycotts have not yet occurred (at least not at a large scale). With the increasing expansion of a formal value chain, it is also expected that the likelihood to have such events will be even lower.

Finally, it is also important to underscore as well the growth potential of urban livestock farmers as well as other actors in the urban (informal) livestock supply chain. Ethiopian diets are increasingly diversifying with income growth and urbanization. Urban ASF producers will be key to ensure urban food security at least in the short term, as poor rural infrastructure still limits the supply of ASFs from rural areas to towns and city centres. Policy makers should thus recognize the significance of urban livestock production systems and actively support these systems.

6. Limitations and the way forward

Religion has revealed itself as a ‘true’ devil in the detail during this dissertation and singling out the impact of religion is a laborious and sensitive task that takes time and effort. Survey questions on religion – and more specifically religious beliefs and participation in religious practices – might be especially prone to social desirability bias. Since we are not able to single out to what extent social desirability bias impacts the answers to such questions, we did not use such data as explanatory variables in our regression analyses. We rather turned to innovative approaches to overcome social desirability biases, which obviously have some shortcomings which we will discuss below.

First, to study the impact of the occurrence of an official Orthodox fasting period – independent of whether or not a household participates – on milk consumption, milk production and milk output use, we used two secondary datasets. Even though both datasets are not intended to map the impact of fasting, this lack of focus on fasting, proved to be beneficial as it reduces the chance that respondents answer milk consumption, production or milk output questions in a socially desirable manner. The way in which the surveys were implemented – where part of the recall data collected overlapped with two long fasting periods within the Orthodox community – allowed us to construct fasting indicators that labelled a household record as fasting if at least part of the recall period for consumption, production and/or output use coincided with a long fasting period. Recall periods⁵³ were clearly articulated in the studies and asked respondents to indicate consumption in the seven days prior to the interview and production and output use in the month prior to the interview. However, it might be that farmers are not able to exactly recall the milk amounts they have consumed and/or produced, the amounts of processed milk being processed, their sales volumes, and price data. While respondents might under- or overreport consumption, production or milk output use, one does not expect that the likelihood of misreporting differs across the group of household whose data (partially) overlapped with the occurrence of a fasting period versus the group of households where the recall period did not overlap (Chapter 3) or overlapped less (Chapter 4) with an official fasting period. Yet, we are not able to exactly know the impact of recall biases on the data. We acknowledge this limitation. Furthermore, both datasets include data that are cross-sectional, which implies that the households whose data were labelled as fasting are not the same as those households who were labelled as non-fasting. The random sampling procedure adopted by the two datasets should avoid biases between these two groups. Including household and location controls further reduces potential biases as much as possible. Yet, one cannot fully eliminate the presence of biases. Therefore, follow-up studies on Orthodox fasting practices should try to focus on a cohort of

⁵³ We can expect diaries to suffer less from reporting errors as consumption is able to be recorded soon after it occurs. Yet, the extent to which diaries are supervised will remain important to ensure they are filled in frequently. There seems to be a trade-off between accuracy and increasing costs for conducting representative consumption data.

households before, during, and after fasting and use supervised diaries so as to better assess the impact of fasting on milk consumption, production, output use as well as nutritional and health outcomes. Although cohort data are obviously more detailed than the cross-sectional and recall data we used, it might become more complex to control for social desirability bias because of the specific timings that these surveys will have to be carried out and the supervision that is required to make these diaries data better than the recall data.

Second, to study the effect of sharing religious ties on milk transactions, we used an innovative approach by employing DCEs. Since no data are available on milk transaction details, we had to collect our own data. Directly asking respondents to detail their preferences for religious in-group or out-group trading partners is not an option, given the likely occurrence of social desirability bias. Different approaches exist to collect behavioural data and to simultaneously reduce potential social desirability biases such as the use of social desirability scales, inferred valuation techniques, bogus pipeline procedures, randomized response and unmatched count techniques, and implicit association tests. These methods have often been used in lab experiments, which offer a controlled environment. However, their usefulness in a developing context is highly questioned as they often require educated subjects and/or technological infrastructure. Game theory is another method that is being used for examining human behaviour in social situations of cooperation (e.g. prisoners' dilemmas and public good games), coordination (e.g. stag hunt) and conflict (e.g. zero-sum games) [475]. Experimental economists have been interested in behavioural changes that might occur when subjects interact with either in-group or out-group members in games. While games have been performed more often in low-income settings, they remain highly hypothetical and do not allow for a realistic operationalization of individual choices, especially not in the case of milk transactions. Furthermore, games do not allow to determine the decision weight that a respondent places on each attribute. Moreover, games might more easily trigger social desirable responding because religion is primed more in game settings due to the simplistic set-ups of commonly played games. Therefore, we turned to DCEs to elicit and quantify religious preferences. When DCEs are conducted in low-income settings, it is recommended to augment secondary sources used to define the attributes with primary data to ensure that the experiment is tailored to the study setting. During a first data collection round in January-February 2016, we interviewed 304 milk producers which allowed us to gain insight in their current milk marketing strategies and transaction details. This set the stage to accurately determine the most valid attributes in the study area of Mekelle. Also for the set-up of the DCE among consumers, various informal discussions with purchasing households informed the selection of the attributes. Attributes included for both consumers and producers were checked with a panel of local experts and pre-tested with 30 consumers and 30 producers to further finetune the included attributes and their associated levels. Still one could question whether the DCEs we constructed are the most appropriate tool for measuring religious preferences. Moreover, DCEs display hypothetical

preferences and it is still possible that people would react differently in real life. Further studies are needed to finetune our design but also to validate our findings by repeating the experiment. As such future experiments should include sales volumes as an attribute in the experiment to see whether religious preferences become more pronounced when larger volumes of milk are involved in the transactions. Furthermore, this experiment should be repeated in different religious settings with larger sample sizes so as to better assure that the sampled respondents are accurately representing the population. Moreover, future studies could benefit from incentivized decisions, where respondents' decisions are coupled with actual payments, so that the decisions made are a more realistic representation of the respondents' true underlying preferences.

Finally, the findings of this dissertation are specific to the studied research localities and thus cannot be extrapolated as such. We largely focused on urban and dominantly Orthodox settings, studying only two of the milk sheds in the country. Furthermore, the impact of fasting was studied for only a particular period in the year (December-April). Therefore, it would be good to collect detailed data across several locations in the country and repeated observations over time. Moreover, this dissertation focused solely on milk producers within the milk supply chain. Yet, it would be interesting to study the impact of Orthodox fasting on other supply chain actors in more detail, and particularly the processing chain. Our findings hold for the Ethiopian milk system, yet might differ across other ASF systems in the country. For meat products, for example, market segmentation will be strong, given the different set of livestock slaughtering rituals. Future research should thus tackle other food commodities, other religious communities, and other countries so as to get a comprehensive overview of the different ways in which religion influences food system development. Although we studied the impact of religion in a low-income setting, religious food laws will continue to shape food systems worldwide. Future research should therefore further explore how religion can positively impact food systems in high-income countries. Tieman [476] has opened this discussion by claiming that religious (Jewish, Christian, and Islamic) food laws can provide answers to current issues with the industrialized food production as well as consumerism, and can move a society to a more sustainable and healthy food system.

Supplementary material

A. Supplementary material - Chapter 3

A.1. Table with dependent and independent variables included in the Probit regressions

Table S3-1: Variables names, definitions and descriptive statistics

Variable	Definition	Mean or proportion
Dependent variables		
Milk consumption	Dummy variable equal to 1 if a household consumed milk in the week prior to the interview; 0 otherwise	0.34
Consumed milk sourced from purchase	Dummy variable equal to 1 if (part of) the milk consumed by the household is sourced through purchase; 0 otherwise	0.40
Independent variables		
Religious affiliation	Nominal variable equal to 1 if the religious affiliation of the household head is Orthodox, 2 for Protestant, 3 for Muslim, and 4 for other religious affiliations (e.g. Catholic, Pegan, Wakifata and traditional faiths); we assumed that the religious affiliation of the household head corresponds to the prevailing religious orientation within a family.	
	Proportion Orthodox households	0.50
	Proportion Protestant households	0.18
	Proportion Muslim households	0.29
	Proportion Other households	0.03
Interview period	As we have no information on whether or not a household participated in the Lent fasting, we matched the one-week period of consumption data with the Lent period. This resulted in a dummy variable equal to 0 if records reflect consumption during non-fasting days, and 1 if (part of) the records were collected during fasting days.	0.34
EA Orthodox concentration	Continuous variable (ranging from 0 to 1) representing the share of Orthodox households relative to the other religions at enumeration area-level; this variable was calculated by dividing the number of interviewed Orthodox members by the total number of religious members (irrespective of religious affiliation), accounting for household size.	0.50 (0.01)
EA church concentration	Continuous variable (ranging from 0 to 1) representing the share of churches relative to the total number of churches and mosques at enumeration area-level	0.61 (0.01)
Household controls		
Sex head	Dummy variable equal to 1 if household head is male; 0 otherwise	0.70

Age head	Continuous variable reflecting the age of the household head (years)	44.15 (0.22)
Marital status head	Dummy variable equal to 1 if household head is married (monogamous or polygamous); 0 otherwise	0.68
Educational background head	Ordinal variable equal to 0 if household head is illiterate or received informal/non-regular education (e.g. Koran education); 1 if household attended primary education; 2 for secondary education; and 3 for college/university education	
	Proportion illiterate or informal education	0.53
	Proportion primary education	0.28
	Proportion secondary education	0.14
	Proportion college/university education	0.06
Number of young children	Continuous variable representing the number of household members less or equal to 6 years old	0.88 (0.01)
Dummy young children	Dummy variable equal to 1 if the household has at least one young child; 0 otherwise	0.52
Number of children	Continuous variable representing the number of household members between 7 and 9 years old	0.45 (0.01)
Number of elderly	Continuous variable representing the number of household members greater or equal to 65 years old	0.18 (0.01)
Number of remaining members	Continuous variable representing the number of household members greater than 9 years and less or equal to 64 years old	3.31 (0.03)
Dairy cow herd size	Continuous variable representing the number of female cows owned by the household and that gave milk during the past 12 months prior to the interview	0.38 (0.01)
Dummy dairy cows	Dummy variable equal to 1 if the household has at least one female cow that gave milk during the past 12 months prior to the interview; 0 otherwise	0.24
Dairy goat herd size	Continuous variable representing the number of female goats owned by the household and that gave milk during the past 12 months prior to the interview	0.20 (0.02)
Logarithm of income	Continuous variable representing the logarithm of the nominal weekly consumption of a household. It is used to proxy a household's living standard. The variable is included in the LSMS dataset and is calculated based on the consumption from three sources: food, non-food purchases, and education expenses (ETB/week)	5.82 (0.01)
Credit	Dummy variable equal to 1 if someone within the household borrowed on credit during the past year prior to the interview; 0 otherwise	0.25
Location controls		
Location	Nominal variable equal to 0 if a household resides in a rural area, 1 for urban small-town area, and 2 for urban large town area	
	Proportion rural	0.63
	Proportion small town (urban)	0.09

Region	Proportion large town (urban)	0.28
	Nominal variable representing the regional state where the household resides	
	Proportion Tigray	0.12
	Proportion Afar	0.03
	Proportion Amhara	0.20
	Proportion Oromia	0.20
	Proportion Somali	0.06
	Proportion Benshagul Gumuz	0.02
	Proportion SNNP	0.23
	Proportion Gambelia	0.02
	Proportion Harari	0.03
	Proportion Addis Ababa	0.06
	Proportion Direedwa	0.04
Milk price	Continuous variable representing the prevailing milk price for a household. The variable was calculated using the approach adopted by LSMS. First, prices were calculated for those households that had purchased milk (amount paid/amount purchased). Then the price was set as the median price at the lowest geographical unit for which there were at least 10 price observations (ETB)	12.03 (0.03)
Distance to the nearest market	Continuous variable representing the distance of a household to the nearest market (in kilometres)	54.05 (0.70)

A.2. Robustness check of Probit regressions

To test the robustness of our results shown in Table 3-2, we ran an additional Probit regression (Table S3-2) that now includes continuous variables for both young children and dairy cows, instead of two dummy variables as included in Table 3-2. The results of including two continuous variables instead of two dummy variables show to be fairly similar to those reported in Table 3-2.

Table S3-2: Results from Probit models modelling the likelihood of a household to have consumed milk in the last seven days prior to the interview now including continuous variable for young children and dairy cows

	Probit 1	Probit 2	Probit 3	Probit 4	Probit 5	Probit 6	Probit 7
Religious affiliation (<i>Orthodox Christian omitted</i>)							
Protestant	-0.16 (0.18)	-0.04 (0.15)	-0.07 (0.16)	-0.14 (0.17)	-0.05 (0.15)	-0.09 (0.14)	0.08 (0.08)
Muslim	0.24 (0.16)	0.34 (0.15)**	0.27 (0.15)*	0.29 (0.16)*	0.32 (0.15)**	0.29 (0.14)**	0.34 (0.08)***
Other	0.53 (0.29)*	0.39 (0.23)*	0.37 (0.25)	0.53 (0.28)*	0.37 (0.23)	0.33 (0.21)	0.33 (0.14)**
Interview period (<i>non-fasting omitted</i>)							
Fasting	-0.53 (0.29)**	-0.46 (0.23)**	-0.39 (0.23)*	-0.53 (0.23)**	-0.40 (0.23)*	-0.50 (0.16)***	-0.21 (0.05)***
EA Orthodox concentration	-0.36 (0.17)**	-0.36 (0.17)**	-0.36 (0.17)**	-0.35 (0.17)**	-0.36 (0.17)**	-0.40 (0.15)***	-0.38 (0.10)***
Interaction (religious affiliation * interview period) (<i>Orthodox Christian * non-fasting omitted</i>)							
Protestant * fasting	0.54 (0.31)*	0.34 (0.27)	0.43 (0.28)	0.50 (0.30)*	0.41 (0.27)	0.54 (0.16)***	-
Muslim * fasting	0.27 (0.27)	0.10 (0.25)	0.16 (0.25)	0.27 (0.26)	0.17 (0.25)	0.27 (0.16)*	-
Other * fasting	-0.39 (0.64)	0.63 (0.43)	-0.03 (0.56)	0.26 (0.54)	0.68 (0.43)	0.80 (0.30)***	-
Interaction (religious affiliation * EA Orthodox concentration) (<i>Orthodox Christian omitted</i>)							
Protestant * EA Orthodox concentration	-0.02 (0.30)	-0.08 (0.30)	-0.03 (0.30)	-0.05 (0.30)	-0.06 (0.30)	0.04 (0.24)	-
Muslim * EA Orthodox concentration	-0.15 (0.29)	-0.19 (0.29)	-0.12 (0.29)	-0.21 (0.29)	-0.17 (0.29)	-0.11 (0.23)	-
Other * EA Orthodox concentration	-1.16 (0.60)*	-1.17 (0.60)*	-1.16 (0.60)*	-1.19 (0.60)**	-1.17 (0.60)*	-1.09 (0.46)**	-
Interaction (interview period * EA Orthodox concentration) (<i>non-fasting omitted</i>)							
Fasting * EA Orthodox concentration	0.04 (0.27)	0.05 (0.27)	0.12 (0.27)	-0.03 (0.27)	0.06 (0.27)	0.18 (0.18)	-
Interaction (religious affiliation * interview period * EA Orthodox concentration) (<i>Orthodox Christian * non-fasting omitted</i>)							
Protestant * fasting * EA Orthodox concentration	0.29 (0.50)	0.37 (0.48)	0.18 (0.49)	0.39 (0.49)	0.27 (0.48)	-	-
Muslim * fasting * EA Orthodox concentration	0.22 (0.43)	0.25 (0.43)	0.13 (0.43)	0.28 (0.43)	0.18 (0.42)	-	-
Other * fasting * EA Orthodox concentration	1.40 (1.07)	0.27 (0.93)	1.11 (1.05)	0.61 (0.97)	0.22 (0.93)	-	-
Number of young children	0.00 (0.04)	0.05 (0.03)*	0.09 (0.02)***	0.01 (0.04)	0.09 (0.02)***	0.09 (0.02)***	0.09 (0.02)***
Interaction (interview period * number of young children) (<i>non-fasting omitted</i>)	0.32 (0.07)**	0.15 (0.05)***	-	0.28 (0.07)***	-	-	-
Interaction (religious affiliation * interview period * number of young children) (<i>Orthodox Christian omitted</i>)							

Additionally, we ran more extended models for Probit regression modelling the likelihood of a household to consume milk. First of all, we ran additional models using church density instead of Orthodox density, to approximate the dominance of Christian congregations in each EA. Other important additions were the inclusion of extra control variables for household characteristics (e.g. age squared of the household head, the interaction term of age and gender of the household head, a more detailed categorization of household composition where we split out young children in infants below the age of 1 and children between 1 and 6 years old, and whether or not a household took credit in the past year) and location characteristics (e.g. the interaction term of region and milking cow herd size, the distance of a household's residence to the nearest market, the interaction term of distance to the market and milking cow herd size, and the three way interaction between location, milk price and milking cow herd size). The regression results can be found in the tables below.

Generally, we observe that the inclusion of church concentration (Tables S3-4) yields more significant effects than when accounting for the density of Orthodox Christians in an EA (Tables S3-3). The church density variable represents all possible Christian congregations rather than only the Orthodox community. We thus observe that in dominantly Christian settings, the impact of religion on milk intake decisions is bigger. Furthermore, we see that our results remain fairly robust when incorporating extra control variables, although the effects become smaller. Firstly, Muslim households are more likely to consume milk compared to Orthodox households. Secondly, Orthodox fasting reduces the likelihood to consume milk, irrespective of the religious group (in Table S3-3 the p value is 0.131). This effect is especially strong for Orthodox households suggested by the negative interaction between Orthodox affiliation, fasting, and milking cow herd size. The impact of Orthodox fasting is also bigger for the Muslim community as compared to the Protestant households. Furthermore, we observe that an increasing density of Orthodox Christians and churches negatively impacts milk intake decisions, *ceteris paribus*. This effect, however, is dependent on the interview period and the religious affiliation of the household. Whereas an increasing density of Orthodox Christians reduces milk intake for all religious groups both during fasting and non-fasting periods (Table S3-3), the impact of church concentration is mixed (Table S3-4). As such, we observe that an increasing church concentration barely affects milk intake decisions of Orthodox households during fasting. Protestant households are increasingly likely to consume milk during non-Orthodox fasting periods with rising church concentration but an opposite trend is observed during fasting. Muslim households consume significantly less milk during with increasing church density irrespective whether it is an Orthodox fasting or non-fasting period.

Table S3-3: Results from the extended Probit models modelling the likelihood of a household to consume milk accounting for the density of Orthodox Christians in an enumeration area

		Probit 1	Probit 2	Probit 3	Probit 4	Probit 5	Probit 6	Probit 7
Religious affiliation (<i>Orthodox Christian omitted</i>)								
	Protestant	0.24 (0.07)***	0.07 (0.08)	0.07 (0.13)	0.07 (0.08)	-0.08 (0.14)	-0.04 (0.15)	-0.08 (0.16)
	Muslim	0.54 (0.06)***	0.50 (0.07)***	0.36 (0.13)***	0.34 (0.08)***	0.31 (0.14)**	0.34 (0.15)**	0.34 (0.16)**
	Other	0.45 (0.13)***	0.26 (0.16)	0.54 (0.20)***	0.30 (0.14)**	0.34 (0.21)	0.38 (0.23)	0.36 (0.25)
Interview period (<i>non-fasting omitted</i>)								
	Fasting	-	-0.35 (0.07)***	-	-0.21 (0.05)***	-0.45 (0.16)***	-0.36 (0.23)	-0.34 (0.23)
EA Orthodox concentration		-	-	-0.37 (0.14)***	-0.39 (0.10)***	-0.37 (0.15)**	-0.33 (0.17)**	-0.35 (0.17)**
Interaction (religious affiliation * interview period) (<i>Orthodox Christian * non-fasting omitted</i>)								
	Protestant * fasting	-	0.45 (0.12)***	-	-	0.53 (0.16)***	0.41 (0.27)	0.46 (0.28)
	Muslim * fasting	-	0.11 (0.11)	-	-	0.23 (0.16)	0.12 (0.25)	0.13 (0.25)
	Other * fasting	-	0.56 (0.28)**	-	-	0.79 (0.30)***	0.67 (0.43)	-0.00 (0.56)
Interaction (religious affiliation * EA Orthodox concentration) (<i>Orthodox Christian omitted</i>)								
	Protestant * EA Orthodox concentration	-	-	0.14 (0.24)	-	0.01 (0.24)	-0.06 (0.30)	-0.00 (0.30)
	Muslim * EA Orthodox concentration	-	-	-0.09 (0.23)	-	-0.12 (0.23)	-0.20 (0.29)	-0.17 (0.29)
	Other * EA Orthodox concentration	-	-	-0.93 (0.45)**	-	-1.14 (0.46)**	-1.23 (0.60)**	-1.18 (0.60)*
Interaction (interview period * EA Orthodox concentration) (<i>non-fasting omitted</i>)								
	Fasting * EA Orthodox concentration	-	-	-	-	0.10 (0.18)	-0.01 (0.27)	0.06 (0.27)
Interaction (religious affiliation * interview period * EA Orthodox concentration) (<i>Orthodox Christian * non-fasting omitted</i>)								
	Protestant * fasting * EA Orthodox concentration	-	-	-	-	-	0.20 (0.48)	0.09 (0.49)
	Muslim * fasting * EA Orthodox concentration	-	-	-	-	-	0.20 (0.43)	0.13 (0.43)
	Other * fasting * EA Orthodox concentration	-	-	-	-	-	0.22 (0.93)	1.05 (1.04)
Interaction (religious affiliation * interview period * milking cow herd size) (<i>Orthodox Christian * non-fasting omitted</i>)								
	Orthodox Christian * fasting * milking cow herd size	-	-	-	-	-	-	-0.18 (0.08)**
	Protestant * non-fasting * milking cow herd size	-	-	-	-	-	-	0.04 (0.11)
	Protestant * fasting * milking cow herd size	-	-	-	-	-	-	-0.07 (0.16)
	Muslim * non-fasting * milking cow herd size	-	-	-	-	-	-	-0.04 (0.11)
	Muslim * fasting * milking cow herd size	-	-	-	-	-	-	-0.09 (0.13)
	Other * non-fasting * milking cow herd size	-	-	-	-	-	-	-0.02 (0.21)

Other * fasting * milking cow herd size	-	-	-	-	-	-	1.43 (0.71)**
Household controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Location controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-4.74 (0.69)***	-4.59 (0.70)***	-4.37 (0.71)***	-4.29 (0.70)***	-4.22 (0.72)***	-4.26 (0.72)***	-4.16 (0.73)***
Pseudo R ²	0.27	0.28	0.27	0.28	0.28	0.28	0.28

Note: ***, ** and * represent statistical significance at a probability of less than 1%, 5%, and 10% respectively. Standard errors are given between parentheses.

Table S3-4: Results from the extended Probit models modelling the likelihood of a household to consume milk accounting for the density of churches in an enumeration area

		Probit 1	Probit 2	Probit 3	Probit 4	Probit 5	Probit 6	Probit 7
Religious affiliation (<i>Orthodox Christian omitted</i>)								
	Protestant	0.24 (0.07)***	0.07 (0.08)	0.08 (0.23)	0.28 (0.07)***	-0.18 (0.24)	-0.68 (0.32)**	-0.70 (0.32)**
	Muslim	0.54 (0.06)***	0.50 (0.07)***	0.71 (0.11)***	0.45 (0.07)***	0.58 (0.13)***	0.53 (0.14)***	0.54 (0.14)***
	Other	0.45 (0.13)***	0.26 (0.16)	0.95 (0.52)*	0.56 (0.15)***	0.64 (0.52)	0.97 (0.58)*	0.92 (0.60)
Interview period (<i>non-fasting omitted</i>)								
	Fasting	-	-0.35 (0.07)***	-	-0.26 (0.05)***	-0.55 (0.14)***	-0.67 (0.17)***	-0.64 (0.17)***
EA church concentration								
		-	-	-0.02 (0.11)	-0.21 (0.09)**	-0.15 (0.13)	-0.21 (0.14)	-0.24 (0.14)*
Interaction (religious affiliation * interview period) (<i>Orthodox Christian * non-fasting omitted</i>)								
	Protestant * fasting	-	0.45 (0.12)***	-	-	0.42 (0.13)***	1.53 (0.47)***	1.56 (0.47)***
	Muslim * fasting	-	0.11 (0.11)	-	-	0.27 (0.14)*	0.38 (0.20)*	0.36 (0.21)*
	Other * fasting	-	0.56 (0.28)**	-	-	0.68 (0.31)**	-1.28 (1.39)	-0.45 (1.43)
Interaction (religious affiliation * EA church concentration) (<i>Orthodox Christian omitted</i>)								
	Protestant * EA church concentration	-	-	0.24 (0.27)	-	0.36 (0.27)	0.93 (0.36)**	0.93 (0.36)**
	Muslim * EA church concentration	-	-	-0.69 (0.21)***	-	-0.67 (0.21)***	-0.60 (0.25)**	-0.58 (0.26)**
	Other * EA church concentration	-	-	-0.45 (0.60)	-	-0.36 (0.60)	-0.76 (0.68)	-0.72 (0.69)
Interaction (interview period * EA church concentration) (<i>non-fasting omitted</i>)								
	Fasting * EA church concentration	-	-	-	-	0.18 (0.17)	0.35 (0.22)	0.43 (0.22)**
Interaction (religious affiliation * interview period * EA church concentration) (<i>Orthodox Christian * non-fasting omitted</i>)								
	Protestant * fasting * EA church concentration	-	-	-	-	-	-1.32 (0.54)**	-1.42 (0.56)**
	Muslim * fasting * EA church concentration	-	-	-	-	-	-0.16 (0.38)	-0.23 (0.39)
	Other * fasting * EA church concentration	-	-	-	-	-	2.23 (1.56)	0.76 (1.67)
Interaction (religious affiliation * interview period * milking cow herd size) (<i>Orthodox Christian * non-fasting omitted</i>)								
	Orthodox Christian * fasting * milking cow herd size	-	-	-	-	-	-	-0.22 (0.09)**
	Protestant * non-fasting * milking cow herd size	-	-	-	-	-	-	0.08 (0.11)
	Protestant * fasting * milking cow herd size	-	-	-	-	-	-	0.02 (0.17)
	Muslim * non-fasting * milking cow herd size	-	-	-	-	-	-	-0.09 (0.12)
	Muslim * fasting * milking cow herd size	-	-	-	-	-	-	-0.07 (0.13)
	Other * non-fasting * milking cow herd size	-	-	-	-	-	-	0.05 (0.25)

Other * fasting * milking cow herd size	-	-	-	-	-	-	0.00 (0.00)
Household controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Location controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-4.74 (0.69)***	-4.59 (0.70)***	-4.88 (0.72)***	-4.56 (0.71)***	-4.58 (0.73)***	-4.53 (0.74)***	-4.42 (0.75)***
Pseudo R ²	0.27	0.28	0.27	0.27	0.28	0.28	0.28

Note: ***, ** and * represent statistical significance at a probability of less than 1%, 5%, and 10% respectively. Standard errors are given between parentheses.

B. Supplementary material - Chapter 4

B.1. Sampling strategy

Dairy farming households are sampled from three subpopulations in and around Ethiopia's capital city, Addis Ababa: rural, sub-urban and urban populations. For rural producers, a three-step sampling process is followed. First, all woredas (an Ethiopian administrative unit comprising several kebeles or villages) of the rural regions are ranked and divided into quartiles based on remoteness (travel time) to Addis Ababa. 10 woredas are randomly selected, proportional to the number of cows (four in Q1, and two each in Q2, Q3 and Q4). In a second step, three kebeles are selected from within each withheld woreda. For Q1 and Q2, a distinction is made between major road access kebeles and non-major road access kebeles. Two kebeles are randomly selected from the former category and one from the latter. Within Q3 and Q4, no such distinction is made and three kebeles are selected randomly. Finally, within each kebele, a census is drawn up of all households with cows in milk. Of that list, twenty households are selected, ten from those who have three cows or more and ten from those with one or two cows⁵⁴. The sampling procedure for the sub-urban farmers is similar, save for the fact that four kebeles (three on-road, one off-road) are randomly selected within each of the three sub-urban woredas. Finally, for the urban dairy farmers, a household survey was implemented with 30 randomly selected producers with one or two cows. The sampling strategy is summarized in Table Q4-1 while the farmers' geographic locations are shown in Figure S4-1.

Table S4-1: Sampling strategy

	Urban	Sub-urban	Rural				Total
			Q1	Q2	Q3	Q4	
Woreda		3	4	2	2	2	13
On-road kebeles		9	8	4			21
Off-road kebeles		3	4	2	6	6	21
Farms	30	240	240	120	120	120	870

⁵⁴ In case there are not enough households with 3 cows or more, more households are selected from those with one or two cows, until the number of twenty households per kebele is reached.

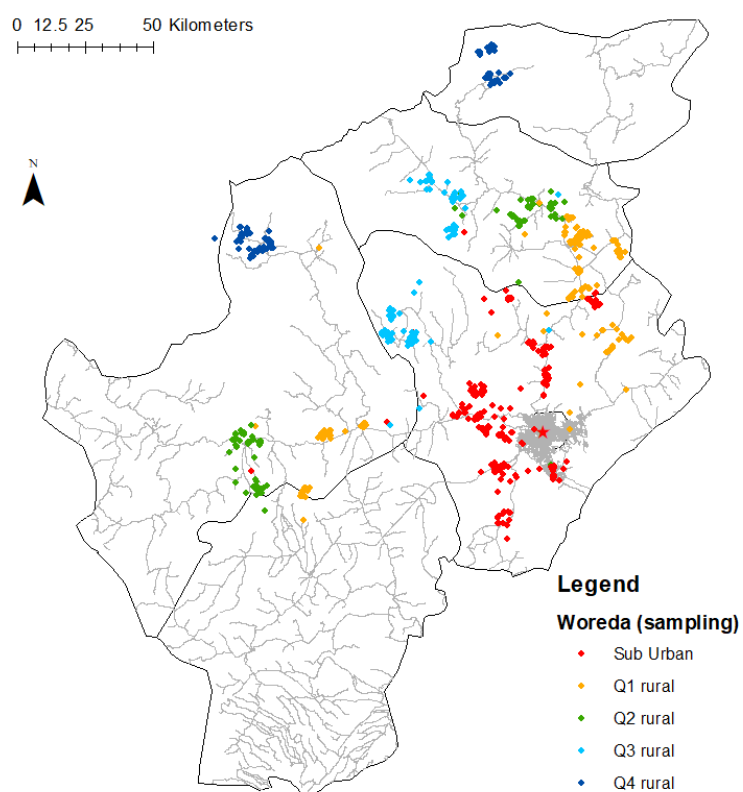


Figure S4-1: Farm locations (the star indicates Addis Ababa)

B.2. Comparison of our sample data with the Living Standard Measurement Survey data

We compare our data with the data we retrieved from LSMS for those households living in the same sample area around Addis Ababa (i.e. Addis LSMS subsample) (Table S4-2). We deliberately select this dataset, since it covers a wide range of household related variables that match the variables in our dataset. Moreover, and more importantly, the period during which consumption data were gathered for the LSMS questionnaire (i.e. February-April 2016) overlaps well with the timing of our own survey. The most important differences are observed in dairy cow ownership and dairy consumption levels, which we anticipated since the LSMS subsample also comprises non-dairy producing households. Moreover, household heads in our sample are more likely to be male, are slightly older, have fewer years of schooling and are predominantly Orthodox. The proportion of Muslims in our sample (1.72%) is considerably lower than that in the area (21%). Household sizes for our dairy producers are slightly bigger than those of more representative households, mostly driven by a higher number of (older) children. Judging by the type and number of assets owned, households in our sample do not appear to be considerably richer or poorer than their LSMS counterparts.

Table S4-2: Descriptive statistics for households in the national Living Standard Measurement Survey, the Addis Ababa sub-sample of the previous dataset and our survey sample along with t-test of difference

	Unit	(1) National LSMS sample (n=4,954)	(2) Addis LSMS subsample (n=842) ^a	(3) Survey sample (n=870)	(4) Difference and p value (3)-(2) ^b
Household head characteristics					
Sex	% male	69.35	65.40	91.6	26.2***
Age	years	46.36 (15.30)	46.60 (15.25)	48.95 (13.71)	2.35***
Schooling	years	3.65 (4.93)	5.03 (5.43)	3.76 (4.27)	-1.27***
Religious affiliation	%				
Orthodox Christian		49.92	70.43	85.00	14.57***
Protestant		17.95	7.24	11.72	4.48***
Muslim		29.29	21.02	1.72	-19.30***
Other		2.62	1.19	1.38	0.19
Marital status	% married	69.34	66.35	90.92	24.57***
Household characteristics					
Household size	#	4.72 (2.38)	4.45 (2.18)	6.02 (2.09)	1.57***
Infants (<1)		0.10 (0.31)	0.07 (0.27)	0.08 (0.28)	0.01
Young children (1-6)		0.78 (0.94)	0.62 (0.86)	0.62 (0.79)	0.01
Children (7-9)		0.41 (0.60)	0.29 (0.51)	0.52 (0.66)	0.23***
Adolescents (10-19)		1.30 (1.31)	1.18 (1.23)	2.11 (1.52)	0.94***
Adults (20-64)		2.25 (1.08)	2.37 (1.19)	2.43 (1.12)	0.07
Elderly (65 and above)		0.20 (0.45)	0.20 (0.44)	0.24 (0.51)	0.04
Asset ownership	#				
Kerosene stove		0.07 (0.28)	0.14 (0.37)	0.10 (0.33)	-0.04**
Modern bed		1.43 (1.40)	1.67 (1.37)	0.60 (0.85)	-1.07***
Sofa/couch		0.17 (0.65)	0.27 (0.57)	0.38 (1.14)	0.11**
Radio		0.35 (0.54)	0.43 (0.54)	0.56 (0.64)	0.12***
Television		0.25 (0.46)	0.43 (0.53)	0.24 (0.49)	-0.19***
Mobile phone		0.96 (1.17)	1.39 (1.45)	0.87 (0.72)	-0.51***
Bicycle		0.03 (0.23)	0.03 (0.19)	0.01 (0.14)	-0.02**
Motorbike		0.02 (0.16)	0.01 (0.11)	0.01 (0.09)	-0.00
Car or truck		0.06 (0.82)	0.10 (0.78)	0.02 (0.17)	-0.07***
Consumption					
Liquid milk intake	L /ad. eq./week	0.34 (1.13)	0.25 (0.57)	0.64 (0.84)	0.39***
Own production		0.20 (1.05)	0.08 (0.29)	0.63 (0.84)	0.55***
Purchased		0.11 (0.42)	0.15 (0.51)	0.00 (0.03)	-0.15***
Gifts and other sources		0.02 (0.21)	0.01 (0.10)	0.00 (0.03)	-0.01**
Cheese intake	L eq./ad. eq. /week	0.05 (0.86)	0.03 (0.14)	0.31 (0.58)	0.28***
Own production		0.04 (0.86)	0.03 (0.12)	0.31 (0.58)	0.28***
Purchased		0.01 (0.07)	0.00 (0.03)	0.00 (0.00)	0.00**
Gifts and other sources		0.00 (0.05)	0.01 (0.07)	0.00 (0.00)	0.01**
Butter intake	L eq./ad. eq./week	0.04 (0.67)	0.05 (0.94)	0.36 (0.48)	0.30***
Own production		0.02 (0.33)	0.01 (0.00)	0.34 (0.47)	0.34***
Purchased		0.03 (0.59)	0.05 (0.94)	0.00 (0.00)	-0.05
Gifts and other sources		0.00 (0.01)	0.00 (0.02)	0.00 (0.00)	0.00**
Consumer liquid milk price	ETB/L	19.39 (17.29)	23.37 (23.44)		

Producer liquid milk price				12.87 (3.27)	
Consumer cheese price	ETB/kg	50.21 (50.58)	53.08 (25.78)		
Producer cheese price				39.31 (19.37)	
Consumer butter price	ETB/kg	168.84 (135.9)	171.28 (105.5)		
Producer butter price				171.17 (43.29)	
Cattle ownership					
Total cattle	#	2.80 (13.37)	2.24 (3.95)	9.46 (6.13)	7.22***
Total cross/exotic cattle	#	0.08 (0.70)	0.12 (0.73)	3.05 (4.78)	2.93***
Total milking cows	#	0.53 (1.14)	0.45 (1.54)	2.82 (2.17)	2.37***

Note: ***, ** and * represent statistical significance at a probability of less than 1%, 5%, and 10% respectively. Means are shown with standard deviations in parentheses. For comparison purposes, kilogram (kg) amounts of processed products are transformed into litre (L) of milk equivalents. The conversion rates used are 20 L/kg for butter and 1.33 L/kg for cheese. 1 USD = 27 ETB at the time of the survey

^a The Addis subsample of the LSMS dataset represents the part of the LSMS in a comparable geographical area as where the survey data of this chapter was collected, i.e., it includes all LSMS households within a concentric circle of 170 kilometres

surrounding Addis Ababa (with 170 km being roughly the furthest distance from Addis in the survey sample).

^b A t-test (proportions test in the case of proportions) was conducted to compare the LSMS Addis subsample with the survey sample.

B.3. Fasting participation and beliefs among Orthodox producing households

No study so far has attempted to map individual adherence to the different officially prescribed fasting periods at an intra-household level in Ethiopia. Several estimates on the number of fasting days annually can be found in the literature, with ranges of from 166-180 days [8, 17] and from 180-250 days [16] being cited. Furthermore, we also detail Orthodox caregivers' beliefs about fasting observance of children. An earlier study by Kim et al. [306] found that in households where ASFs are available, maternal beliefs about children's participation in fasting rituals greatly affect children's ASF consumption in the Lent fast period.

In the survey, respondents (usually the household head) in Orthodox households were asked to indicate for each household member above the age of five years whether or not this member observes any Orthodox fasting event. Since most meals are consumed together within a household, member's observance of fasting should be known to the household head. Moreover, consumption of dairy-based drinks away from home is not widespread in the country⁵⁵. If a member was said to engage in fasting, member's observance was detailed for each of the seven major fasts, as outlined in Table 2-1 in Chapter 2, with a dummy variable (yes/no). If a member participates in a particular fasting event, we assume that this member fasts during the entire prescribed fasting period. As such, we were able to calculate the effective number of fasting days adhered to for 3,945 individual Orthodox household members. Additionally, we asked Orthodox caregivers' opinions about fasting observance by young children using the following four statements: (1) During fasting, a young child less than 2 years old should not observe fasting; (2) During fasting, children 6-23 months of age should continue eating eggs, milk, and meat to grow healthy; (3) During fasting, children 6-23 months of age should continue to eat as often as usual to grow healthy; and (4) During fasting, infants and children under 2 years of age should be breastfed as often as usual to grow healthy. Caregivers were asked to indicate to which degree they agree/disagree with the statements using a 5-point Likert scale (strongly disagree – disagree – somewhat agree – agree – strongly agree). Finally, caregivers were asked to indicate at what age they believe children should begin observing fasting. Both household member fasting adherence and caregivers' beliefs about children fasting participation are descriptively described in the results sections, but we did not include these data as explanatory variables in our regression analyses since we are not able single out to what extent social desirability bias impacts the answers that were given by the respondents.

Table S4-3 summarizes the extent of participation in fasting periods throughout the year for Orthodox Christian households. We observe that adherence varies both by age and by type of fasting period. First, fasting adherence increases with age. Average participation among older children, who are

⁵⁵ Looking descriptively in the LSMS data we used in the previous chapter (Chapter 3), we find that only 7% of the households indicated that members consumed dairy-based beverages outside the home.

requested to participate in fasting periods, is rather low with one-in-five participating. Adolescents do adhere more, 65% on average, while observance reaches 90% among adults and elderly. Surprisingly, we observe that a small proportion (5%) of young children participates in fasting rituals, although they are officially exempt from fasting. Second, participation rates differ greatly across the different obligatory fasting events. We observe that Lent, Felseta fast and weekly fasting periods are the most adhered to, followed, at some distance, by the Nineveh and the Advent fast. The Sene fast, finally, is only adhered to by about half of the adults in our sample. There is no age-specificity in the adherence to certain fasting periods. Finally, no sizeable differences are observed between female and male participation rates and, if anything, women tend to participate slightly more compared to their male counterparts, except within the elderly category.

Overall, we see that the number of fasting days on a yearly basis varies between 4-7 days for young children to about 138-145 days for elderly people. The fasting adherence of adults is around 140 days and thus 20-110 days below the estimates of 166-250 fasting days per year cited) [8, 16, 17]. It should also to be noted that 11-12% of the Orthodox Christian adults do not participate in any fast, possibly because of pregnancy or illness but also out of choice. Moreover, we also observe descriptively in our data that remote households report to adhere more to official fasting periods as compared to non-remote households.

Table S4-3: Participation rates for different fasting periods and total number of fasting days per age-gender combination for members of the Orthodox faith

Fasting period	Length (days)	Young children (5-6)		Older children (7-9)		Adolescents (10-19)		Adults (20-64)		Elderly (65+)	
		M	F	M	F	M	F	M	F	M	F
Any (%)	/	4.7	5.2	22.1	23.3	63.4	66.0	88.0	89.1	91.5	85.5
Nineveh (%)	3	2.4	3.9	14.7	19.2	46.7	50.6	68.0	69.9	76.7	78.2
Lent (%)	55	1.2	3.9	19.0	22.3	60.2	63.4	85.1	86.7	91.5	83.6
Sene (%)	25	1.2	3.9	9.8	14.0	33.3	34.8	51.0	53.9	55.0	52.7
Felseta (%)	15	2.4	3.9	19.0	22.8	60.9	62.7	85.0	85.7	88.4	85.5
Advent (%)	40	2.4	3.9	12.9	17.1	43.1	44.3	65.2	67.6	63.6	65.5
Weekly (%)	44	2.4	3.9	21.5	23.3	62.2	65.1	87.5	88.0	90.7	85.5
Total (# days)	182	4	7	31	37	97	101	139	142	145	138
n		84	76	163	193	852	644	885	859	132	57

Note: We use an average of 25 days for the Sene fast and approximate the number of weekly fasting at 44 days a year, considering other fasting events that overlap with weekly fasting and the exemption of weekly fasting between Easter and Pentecost. M = Male, F = Female.

Additionally, we asked Orthodox households' opinions about fasting observance by young children (Table S4-4). Only 11% of households disagrees or strongly disagrees that children less than 2 years old should not observe fasting. 4% believes that children 6-23 months of age should stop eating ASFs during fasting, 6% argues that these children should eat less frequently during fasting, and 5%

thinks these children should be breastfed less during fasting. In general, Orthodox households in our sample propose that children should start observing fasting at the age of 9.2 years (with a 95% confidence interval of 8.6-9.7 years old). In a study by Kim et al. [306], only half of the caregivers had positive attitudes towards the exemption of children from fasting practices⁵⁶. We find that 96% of the respondents in our sample agrees that children should continue eating ASFs during fasting. Still it is worrisome to find in our data that a number of young children are actively participating or expected to participate in fasting.

Table S4-4: Orthodox respondents beliefs about children's fasting participation

	Strongly disagree (%)	Disagree (%)	Somewhat agree (%)	Agree (%)	Strongly agree (%)
During fasting, a young child less than 2 years old should not observe fasting	7.84	3.44	0.55	14.44	73.73
During fasting, children 6-23 months of age should continue eating eggs, milk, and meat to grow healthy	2.34	1.93	6.19	29.16	60.39
During fasting, children 6-23 months of age should continue to eat as often as usual to grow healthy	3.16	2.75	6.74	29.71	57.63
During fasting, infants and children under 2 years of age should be breastfed as often as usual to grow healthy	1.79	3.30	7.70	26.27	60.94

It is possible that social desirability bias (SDB) is introduced when asking respondents to detail fasting participation of household members and fasting beliefs. Yet, one would expect to observe full participation in all official fasting periods by members who are prescribed to observe fasting if SDB

⁵⁶ The objective of the study by Kim et al. [306] was to investigate the factors influencing ASF consumption among young children (6-23 months old) during the Lent fasting period in western Amhara, Ethiopia. The data used in the study of Kim et al. [306] were gathered during the Lent fasting period in 2015 in three western zones of the Amhara region; while our data were gathered in the Addis region and Oromia region both during and outside Lent. The paper had 2,536 observations, while we only have 870 observations. Maternal beliefs about ASF feeding during fasting were measured in the paper of Kim et al. [306] by two: i.e. 'During the Lent fasting period, children 6-23 months of age should continue eating eggs, milk and meat to grow healthy' and 'Outside of Lent and fasting days, children 6-23 months of age should continue eating eggs, milk and meat to grow healthy'. Both items were measured using a 5-point Likert scale. Answers to both questions were compiled to create an overall score of 10 (range 2–10). The sample was divided into two groups, those with low scores (below 6/10) and high scores (above 6/10). We measured beliefs using four different statements (see Table S4-4; also measured using a 5-point Likert scale). One of our statements (the second one in Table S4-4) was identical to the one in the paper of Kim et al. [306].

would be an issue in the sample. SDB could on the other hand also have led respondents to indicate more often that their children are not participating in fasting periods. But, when we look descriptively in the sample, we find that Orthodox households who have children below the age of five, still feed milk to these children during the Lent fasting period. Still we are not able to fully cancel out the impact of SDB. Therefore, we did not use such data as explanatory variables in our regression analyses, but rather report them descriptively here in this Supplementary material.

B.4. The impact of fasting on dietary diversity

This supplementary material section focuses on a more detailed analysis how consumption changes on individual fasting days. In particular, we assess the impact of a fasting day (self-reported participation as opposed to the calendar approach used in the rest of the chapter) on diet quality. We use data on whether or not certain food groups were consumed (yes/no) using a 24-hour recall period for the household head, the spouse (if present) and the youngest child below the age of five (if present). This allows us to calculate Individual Dietary Diversity Scores (IDDS, see Swindale and Bilinsky [477]), but also to look at the likelihood of consuming different food groups separately. We do this to see whether individuals substitute the forgone consumption of ASFs by increasing their likelihood of consuming other food items.

In our sample, the IDDS during non-fasting days for adults (both the household head and spouse) is around 4, while the one of the youngest child is 3.1 (Table S4-5). Similar values for the IDDS of children below the age of five are reported by Hirvonen et al. [314]. We could not compare the IDDS for spouse and head, since these are not calculated on a regular basis in Ethiopia. We observe a large impact of a fasting day on adults' dietary diversity. Household head and spouse consume, respectively, 0.87 and 0.34 food groups less during a fasting day, which are non-negligible decreases given the average IDDS of 4 during non-fasting days. Crucially, no reduced dietary diversity is observed for the youngest child in the household during a fasting day.

Table S4-5: Impact of a fasting day on daily Individual Dietary Diversity Score

	Daily Individual Dietary Diversity Score		
	Household head	Spouse	Youngest child (<5)
Fasting yesterday (0/1)	-0.87*** (0.12)	-0.34*** (0.12)	0.10 (0.18)
Individual controls	Yes	Yes	Yes
Household controls	Yes	Yes	Yes
Non-fasting mean	4.30	4.08	3.12
n	833	833	698
R ²	0.23	0.24	0.16

Note: ***, ** and * represent statistical significance at a probability of less than 1%, 5%, and 10% respectively. The type of fasting period is a categorical variable whereby no fasting is the reference category. For a complete list of controls, see Table 4-4, Chapter 4. Cluster robust standard errors are in parentheses.

A more detailed analysis of the likelihood to consume different food groups during fasting and non-fasting days is shown in Figure S4-2. A detailed description of the food groups included in an average diet goes beyond the scope of our analysis, so we will focus on the intake of animal protein. During non-fasting days, the probability that a household head consumes ASFs is already low, one-in-three heads eats meat or drink milk, one-in-five consumes butter or cheese and one-in-ten eats eggs and

yoghurt. Fish intake is extremely low (1%). During fasting days, the likelihood that a household head consumes any ASF reduces to almost zero. Spouses on the other hand have a higher probability to consume any ASF during non-fasting days (30-40%) and on fasting days only the likelihood to consume fish, milk, yoghurt and buttermilk goes down but does not fall to zero. The differential impact of fasting days on heads and spouses might suggest that women are prioritized over men in the consumption of livestock products. Strikingly, no substitution occurs from ASFs towards other, equally nutritious food groups on fasting days. It is, however, possible that higher amounts of the same food groups are being consumed, but at least there is no introduction of other food groups into a fasting day diet.

Although we cannot trace back the quantities of ASFs being consumed on non-fasting days, the above analysis reveals that adult household members are more likely to consume livestock products on non-fasting days which could partially compensate for their forgone consumption of ASFs during fasting days. Yet, milk intake levels in our sample are low, which could also explain why we observe a rather small effect of four fasting days a week. Milk consumption per adult equivalent in our sample amounts to 0.64 L in the week before the interview (Table S4-2). If we extrapolate this to a yearly level (for which some caveats certainly apply), this comes down to roughly 33 L. Average yearly milk intake levels in Ethiopia have been estimated at 20 L per capita, which is far below the average in East Africa (40 L per capita per year) [42]. Ethiopia has no published recommended intake for milk, but assessing the average recommended milk intake for those countries that have published standards, we conclude that an average daily consumption of 250 mL of milk is proposed which equals about 90 L per capita per year [23]. Milk intake in our sample is thus nearly double the national estimated average of 20 L/capita/year, but still only one third of the recommended intake of 90 L/capita/year. Yet, according to the EAT-lancet commission, a wide range of intake of milk and derivatives, i.e. between 0-500 g per day, are compatible with a healthy diet.

Finally, for children aged five and below, fasting days do not impact the overall intake of dairy products, although we observe that they consume less beef, pork and lamb on fasting days, probably because these food items are less likely to be consumed and prepared at the household level. Most of the children consume fresh milk (72%) while the consumption of pasteurized milk and powder milk is limited (2%). This is not surprising given the availability of freshly produced milk. Half of the children also consume eggs. Children do consume cheese and butter, although the likelihood is much lower as compared to fresh milk (20-25%). The probability to consume other ASFs (i.e., meat, fish and/or yoghurt) is low (below 10%).

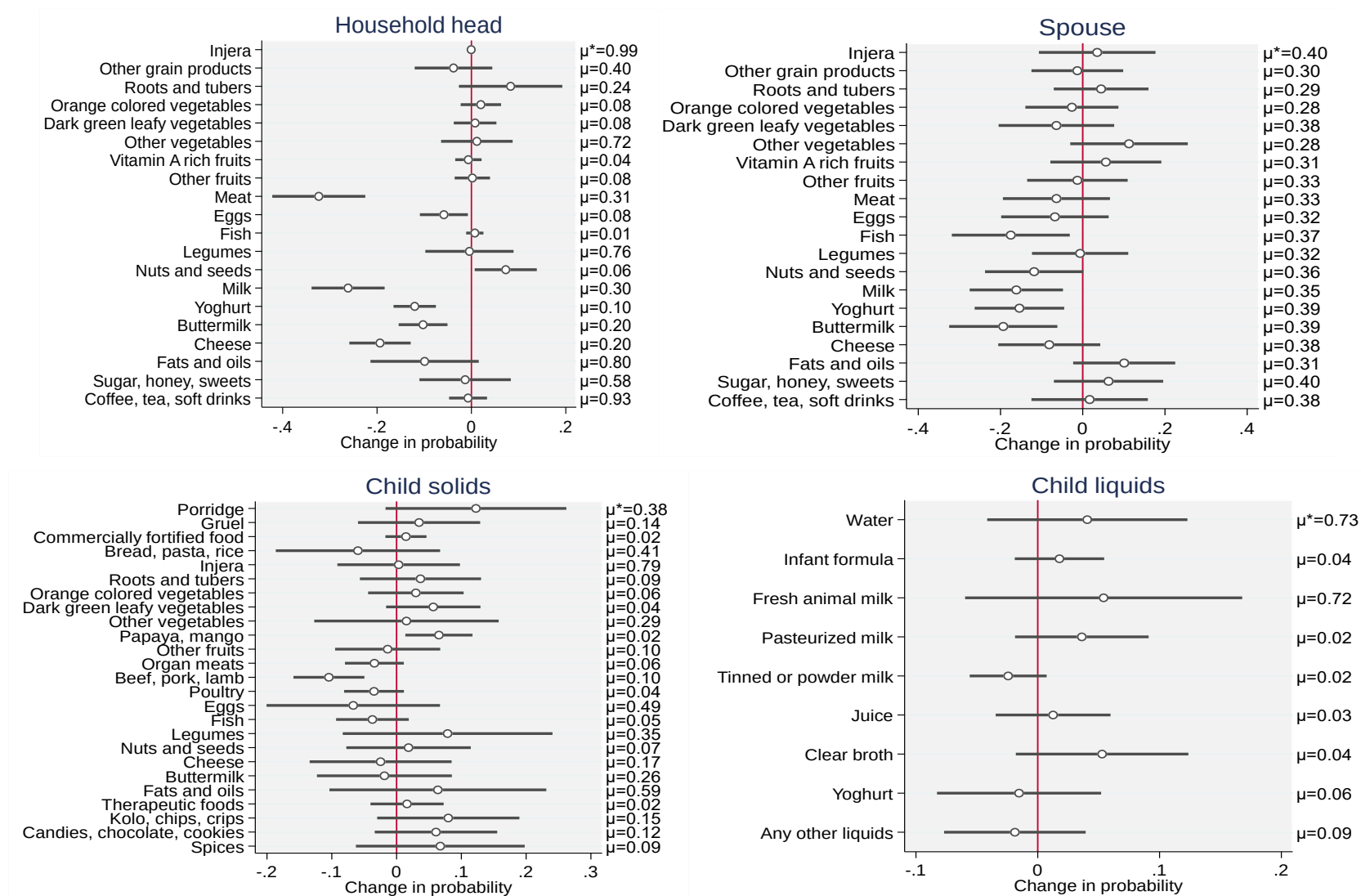


Figure S4-2: Impact of a fasting day on the likelihood of daily consumption of different food groups

Note: *μ denotes the non-fasting mean of the dependent variable. Coefficients of the fasting day indicator are shown along with cluster robust confidence intervals.

B.5. Impact of fasting adherence strictness on consumption of liquid and processed milk

Since we observe a large heterogeneity in fasting adherence, an interesting side-analysis consists in examining whether a varying strictness of fasting participation affects milk consumption patterns differently. To do so, we construct a household fasting days index. We calculate this index using the following steps. First, we internally standardize the number of fasting days by age (in years) following the non-parametric regression procedure of Rubio-Codina et al. [478]. Then, to obtain a household index of the yearly number of fasting days, we take the average of those individual deviations within each household (which explains why the measure is not perfectly centred around zero). Within the context of Ethiopia, this constructed index could be considered as a measure of a household's extent of adherence to Orthodox fasting.

We examine whether this strictness in adherence affects milk consumption patterns. Table S4-6 shows that stricter adherence to Orthodox fasting is not associated with lower household milk intake during non-fasting periods, nor does it impact the youngest child's milk consumption (for both non-fasting and fasting periods). However, the more a household adheres to official Orthodox fasting periods, the less liquid and processed milk is consumed during fasting events. In particular, a one standard deviation increase in the household fasting index is linked with a 33% and 70% reduction in the consumption of liquid milk and processed milk, respectively. This result demonstrates that households that adhere to a higher number of prescribed Orthodox fasting events, also follow the fasting prescriptions during those periods more rigorously, even if milk is available at the household level.

Table S4-6: Linear regression analysis of the impact of the household fasting days index on milk consumption volumes during fasting and non-fasting periods

	Milk consumption					
	Household liquid milk (L/week/ad.eq.)		Household processed milk (L eq./week/ad.eq.)		Child liquid milk (L/week)	
	<i>Not fasting</i>	<i>Fasting</i>	<i>Not fasting</i>	<i>Fasting</i>	<i>Not fasting</i>	<i>Fasting</i>
Household fasting days index	0.05 (0.07)	-0.19*** (0.06)	0.03 (0.11)	-0.47*** (0.06)	0.48 (0.31)	0.39 (0.28)
Individual controls	No	No	No	No	Yes	Yes
Household controls	Yes	Yes	Yes	Yes	Yes	Yes
Mean	0.95	0.57	1.48	0.65	2.92	2.95
n	845	845	842	845	256	256
R ²	0.17	0.15	0.15	0.21	0.28	0.29

Note: ***, ** and * represent statistical significance at a probability of less than 1%, 5%, and 10% respectively. Household amounts are expressed per adult equivalent to account for household size and composition. Household processed milk covers both cheese and butter intake. For a complete list of controls, see Table 4-4, Chapter 4. Cluster robust standard errors are in parentheses.

B.6. The impact of different long fasting season on milk intake

In addition to the analysis in Section 4.2.1, respondents were also asked to recall and report the household's intake of milk, cheese, and butter (all sourced from own production) in the middle of the latest long fasting period during which they had (at least) one cow in milk, with consumption two weeks after this fasting period. The same assessment was asked for the youngest child's milk intake. For the vast majority of the sample, this fasting period was Advent (74%), followed by Lent (17%) and Felseta fast (9%). Respondents indicated that the household's intake of milk, butter and cheese roughly halves during these long fasting periods. Milk intake of the youngest child within a milk producing household is virtually unaffected during long fasting periods (Table S4-7).

Table S4-7: Descriptive statistics of self-reported milk consumption within and outside long fasting episodes

Variable	Unit	Household	Youngest child
Liquid milk consumption			
<i>Non-fasting week</i>	L	4.47 (5.69)	2.91 (3.41)
<i>Fasting week</i>	L	2.69 (3.78)	2.96 (3.39)
Butter consumption			
<i>Non-fasting week</i>	L eq.	4.81 (5.24)	
<i>Fasting week</i>	L eq.	2.16 (3.46)	
Cheese consumption			
<i>Non-fasting week</i>	L eq.	1.75 (3.01)	
<i>Fasting week</i>	L eq.	0.85 (2.12)	
n		870	317

Note: Means are shown with standard deviations in parentheses.

'Fasting week' refers to a week in the last long fasting period when the household had at least one cow in milk.

'Non-fasting week' refers to a week at least 2 weeks after that long fasting period

Additionally, we conduct a Random Effects analysis. Given that there are two time periods for each household, one during one of the fasting periods and one two weeks after, we are able to account for all observed and unobserved heterogeneity between households⁵⁷. Figure A.3 shows the results of this RE analysis for liquid and processed milk, whereby consumption in the middle of the fasting period is always compared to consumption two weeks after its end. We detect that the impact of Lent on household's intake of milk (particularly for liquid milk and butter) seems to be moderate when compared to that of Advent and Felseta fast, which is striking since Lent covers the longest fasting period (55 days as compared to 40 days of Advent fasting and 15 days of Felseta fasting). This might be explained by the fact that milk is more abundant during August (Felseta fast) and December (Advent) compared to February-March

⁵⁷ A Hausman test revealed it was permitted to use the more efficient RE estimator (compared to the consistent fixed effects estimator). This also allows us to assess the importance of other variables.

(Lent) making the difference between fasting and non-fasting weeks potentially larger. Advent fasting cuts household intake levels on average in half, while the effects of Lent and Felseta fast in particular, impact households differently (with reductions ranging between 10-100%), as can be seen from the large confidence intervals (except for cheese consumption). Also, for young children we observe large confidence intervals, but their milk intake seems to be barely affected or goes up slightly (especially during Lent).

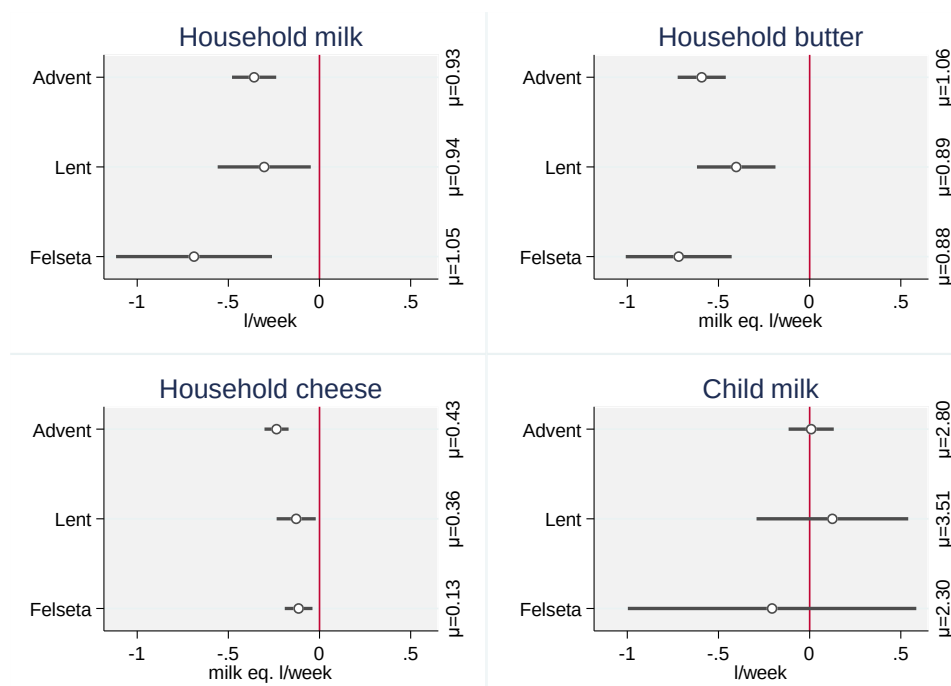


Figure S4-2: Differences in fasting impact on milk consumption depending on type of long fasting period

Note: Coefficients of random effects analysis of latest long fasting period indicator are shown, along with cluster robust confidence intervals. μ denotes the average in a non-fasting week.

C. Supplementary material - Chapter 5

Table S5-1: Hay market arrangement among the identified farm clusters

	Cluster 1 (n = 20)	Cluster 2 (n = 40)	Cluster 3 (n = 7)	Cluster 4 (n = 63)	Cluster 5 (n = 33)
Purchased from (%)					
rural farmer	20.0 ^a	22.5 ^a	57.1 ^a	31.8 ^a	27.3 ^a
trader	80.0 ^a	77.5 ^a	42.9 ^a	69.8 ^a	72.7 ^a
Arrangement (%)					
written	0 ^a	2.5 ^a	0 ^a	0 ^a	0 ^a
about volume bought	5.0 ^b	70.0 ^a	0 ^{bc}	55.6 ^a	0 ^c
about price	0 ^d	72.5 ^a	28.6 ^{bc}	65.1 ^{ab}	9.1 ^{cd}
about quality	90.0 ^{ab}	62.5 ^c	85.7 ^{bc}	38.1 ^d	100 ^a
Purchasing place (%)					
market	95.0 ^{ab}	75.0 ^b	85.7 ^b	81.0 ^b	100 ^a
Purchased volume (%)					
small volumes of hay (kg or bag or donkey)	85.0 ^{ab}	60.0 ^{bc}	100 ^a	49.2 ^c	97.0 ^a
large volumes of hay (car or heap or truck)	15.0 ^{bc}	40.0 ^{ab}	0 ^c	50.8 ^a	3.0 ^c
Purchasing frequency (%)					
weekly	50.0 ^a	17.5 ^c	57.1 ^{ab}	25.4 ^{bc}	51.5 ^a
every 2-4 weeks	40.0 ^a	47.5 ^a	28.6 ^a	25.4 ^a	48.5 ^a
occasionally	10.0 ^{bc}	32.5 ^{ab}	14.3 ^{ab}	47.6 ^a	0 ^c
Payment frequency (%)					
upfront	85.0 ^a	25.0 ^b	85.7 ^a	30.2 ^b	69.7 ^a
at transaction time	10.0 ^b	72.5 ^a	0 ^b	69.8 ^a	30.3 ^b
Minimum price (ETB/donkey) ²	93.4 ^{bc} ± 8.9	132.3 ^a ± 12.9	91.4 ^{abc} ± 9.9	118.9 ^{ab} ± 10.6	80.9 ^c ± 4.1
Maximum price (ETB/donkey) ²	111.6 ^{bc} ± 10.6	216.1 ^a ± 20.1	133.6 ^b ± 21.4	149.23 ± 12.8	100.7 ^c ± 4.7
Price fluctuation (ETB/donkey) ²	18.1 ^c ± 2.7	83.9 ^a ± 12.0	42.1 ^{abc} ± 14.7	36.54 ± 7.3	19.8 ^c ± 2.3

Note: Data in this table are only for those farmers that report to buy hay. Prices are only reported for those farmers that indicated donkeys as purchasing unit (the main purchase volume) as we could not easily convert other units.

Mean ± standard error for the continuous variables and frequencies for the categorical variables.

^{a-d} Means and frequencies within a row with different superscripts differ (p < 0.05).

Table S5-2: Crop residue market arrangement among the identified farm clusters

	Cluster 1 (n = 53)	Cluster 2 (n = 61)	Cluster 3 (n = 35)	Cluster 4 (n = 75)	Cluster 5 (n = 14)
Purchased from (%)					
rural farmer	76.9 ^b	15.3 ^d	100 ^a	38.4 ^c	0 ^d
trader	23.1 ^c	84.8 ^a	2.9 ^d	61.6 ^b	100 ^a
Arrangement (%)					
written	4.3 ^a	1.8 ^a	0 ^a	0 ^a	0 ^a
about volume bought	14.9 ^b	71.9 ^a	2.9 ^b	74.7 ^a	11.1 ^b
about price	10.6 ^{bc}	82.5 ^a	2.9 ^c	91.6 ^a	33.3 ^b
about quality	85.1 ^a	79.0 ^a	94.1 ^a	12.7 ^b	77.8 ^a
Purchasing place (%)					
Market	83.0 ^{bc}	93.0 ^{ab}	97.1 ^a	70.4 ^c	100 ^{abc}
Purchased volume (%)					
small volumes of hay (kg or bag or donkey)	100 ^a	100 ^a	100 ^a	63.4 ^b	100 ^a
large volumes of hay (car or heap or truck)	0 ^b	0 ^b	0 ^b	36.6 ^a	0 ^b
Purchasing frequency (%)					
weekly	57.5 ^a	19.6 ^b	61.8 ^a	28.2 ^b	44.4 ^{ab}
every 2-4 weeks	40.4 ^b	76.8 ^a	32.4 ^{bc}	22.5 ^c	44.4 ^{bc}
occasionally	2.1 ^b	1.8 ^b	5.9 ^b	47.9 ^a	11.1 ^b
Payment frequency (%)					
upfront	70.2 ^a	14.0 ^b	88.2 ^a	8.5 ^b	66.7 ^a
at transaction time	10.6 ^{bc}	82.5 ^a	0 ^c	91.6 ^a	33.3 ^b
Minimum price (ETB/donkey)	110.7 ^{bc} ± 3.4	111.3 ^c ± 6.8	115.6 ^b ± 4.1	206.2 ^a ± 10.0	225.0 ^a ± 25.0
Maximum price (ETB/donkey)	203.6 ^{bc} ± 6.8	223.0 ^b ± 5.6	201.2 ^c ± 4.3	273.6 ^a ± 8.0	260.0 ^{abc} ± 40.0
Price fluctuation (ETB/donkey)	93.0 ^b ± 5.8	111.7 ^a ± 5.0	85.6 ^b ± 4.8	63.3 ^c ± 4.3	35.0 ^c ± 15.0

Note: Data in this table are only for those farmers that report to buy crop residues. Prices are only reported for those farmers that indicated donkeys as purchasing unit (the main purchase volume) as we could not easily convert other units.

Mean ± standard error for the continuous variables and frequencies for the categorical variables.

^{a-d} Means and frequencies within a row with different superscripts differ ($p < 0.05$).

Table S5-3: Wheat bran market arrangement among the identified farm clusters

	Cluster 1 (n = 60)	Cluster 2 (n = 71)	Cluster 3 (n = 38)	Cluster 4 (n = 91)	Cluster 5 (n = 34)
Purchased from (%)					
rural farmer	58.3 ^b	8.5 ^c	86.8 ^a	4.4 ^c	0 ^c
trader	40.0 ^b	87.3 ^a	7.9 ^c	51.1 ^b	73.5 ^a
flour mill	1.7 ^b	4.2 ^b	2.6 ^b	45.6 ^a	26.5 ^a
Arrangement (%)					
written	3.3 ^b	2.8 ^b	0 ^b	28.9 ^a	0 ^b
about volume bought	11.7 ^c	74.7 ^a	2.6 ^c	58.9 ^b	5.9 ^c
about price	15.0 ^b	81.7 ^a	2.6 ^c	73.3 ^a	11.8 ^{bc}
about quality	86.7 ^{ab}	76.1 ^b	94.7 ^a	27.8 ^c	91.2 ^{ab}
Purchasing place (%)					
market	81.7 ^{ab}	90.1 ^a	92.1 ^a	54.4 ^c	73.5 ^{bc}
Purchased volume (kg)	325.3 ^a ± 39.7	452.5 ^a ± 47.9	323.7 ^a ± 55.8	352.6 ^a ± 32.2	217.7 ^b ± 58.2
Purchasing frequency (%)					
weekly	23.3 ^{bc}	14.1 ^c	21.1 ^{bc}	36.7 ^{ab}	44.1 ^a
every 2-4 weeks	76.7 ^a	84.5 ^a	73.7 ^{ab}	61.1 ^b	55.9 ^b
occasionally	0 ^a	0 ^a	5.3 ^a	2.2 ^a	0 ^a
Payment frequency (%)					
upfront	73.3 ^{ab}	16.9 ^c	89.5 ^a	18.9 ^c	70.6 ^b
at transaction time	11.7 ^c	81.7 ^a	0 ^d	81.1 ^a	29.4 ^b
Minimum price (ETB/kg)	4.0 ^b ± 0.1	3.8 ^c ± 0.1	4.1 ^b ± 0.1	4.2 ^a ± 0.1	2.7 ^d ± 0.1
Maximum price (ETB/kg)	5.0 ^a ± 0.2	5.5 ^a ± 0.1	5.3 ^a ± 0.2	5.0 ^b ± 0.1	3.3 ^c ± 0.1
Price fluctuation (ETB/kg)	1.1 ^b ± 0.1	1.7 ^a ± 0.1	1.2 ^b ± 0.1	0.8 ^c ± 0.0	0.6 ^d ± 0.1

Note: Data in this table are only for those farmers that report to buy wheat bran.

Mean ± standard error for the continuous variables and frequencies for the categorical variables.

^{a-d} Means and frequencies within a row with different superscripts differ (p < 0.05).

Table S5-4: *Atella* market arrangement among the identified farm clusters

	Cluster 1 (n = 45)	Cluster 2 (n = 70)	Cluster 3 (n = 28)	Cluster 4 (n = 87)	Cluster 5 (n = 30)
Purchased from (%)					
trader	64.4 ^b	98.6 ^a	32.1 ^c	94.2 ^a	100 ^a
local brewery	24.4 ^b	1.4 ^c	57.1 ^a	3.5 ^c	0 ^c
Arrangement (%)					
written	2.2 ^a	0 ^a	0 ^a	1.2 ^a	0 ^a
about volume bought	22.2 ^{cd}	74.3 ^a	7.1 ^d	60.9 ^{ab}	43.3 ^{bc}
about price	24.4 ^c	85.7 ^a	14.3 ^c	77.0 ^{ab}	63.3 ^b
about quality	82.2 ^a	28.6 ^b	92.9 ^a	24.1 ^b	86.7 ^a
Purchasing place (%)					
market	40.0 ^b	37.1 ^b	21.4 ^b	90.8 ^a	100 ^a
Purchased volume (L)	127.6 ^b ± 27.0	205.7 ^a ± 23.9	125.4 ^b ± 32.4	115.6 ^b ± 18.9	77.9 ^b ± 6.5
Purchasing frequency (%)					
daily	8.9 ^{bc}	15.7 ^b	0 ^c	66.7 ^a	6.9 ^{bc}
weekly	68.9 ^{ab}	81.4 ^a	75.0 ^{ab}	25.3 ^c	58.6 ^b
every 2-4 weeks	22.2 ^a	2.9 ^b	25.0 ^a	6.9 ^b	34.5 ^a
Payment frequency (%)					
upfront	40.0 ^b	11.4 ^d	28.6 ^{bc}	17.2 ^{cd}	70.0 ^a
at transaction time	4.4 ^c	10.0 ^c	0 ^c	73.6 ^a	26.7 ^b
weekly to monthly	55.6 ^b	78.6 ^a	71.4 ^{ab}	9.2 ^c	3.3 ^c
Minimum price (ETB/L)	0.6 ^a ± 0.2	0.3 ^c ± 0.0	0.5 ^b ± 0.1	0.3 ^c ± 0.0	0.3 ^d ± 0.0
Maximum price (ETB/L)	0.7 ^{abc} ± 0.2	0.4 ^c ± 0.0	0.5 ^b ± 0.1	0.4 ^d ± 0.0	0.3 ^e ± 0.0
Price fluctuation (ETB/L)	0.0 ^b ± 0.0	0.1 ^a ± 0.0	0.0 ^c ± 0.0	0.1 ^a ± 0.0	0.1 ^a ± 0.0

Note: Data in this table are only for those farmers that report to buy *atella*.

Mean ± standard error for the continuous variables and frequencies for the categorical variables.

^{a-d} Means and frequencies within a row with different superscripts differ ($p < 0.05$).

Table S5-5: Butter marketing strategies among the identified farm clusters

	Cluster 1 (n = 48)	Cluster 2 (n = 51)	Cluster 3 (n = 1)	Cluster 4 (n = 8)	Cluster 5 (n = 4)
Butter buyer (%)					
neighbours	89.6 ^a	88.2 ^a	100	87.5 ^a	100 ^a
Farmers who have more than 1 type of butter buyer (%)	0 ^a	2.0 ^a	0	12.5 ^a	0 ^a
Arrangement for butter (%)					
written	0 ^a	0 ^a	0	0 ^a	0 ^a
about butter volume	8.3 ^b	56.0 ^a	100	75.0 ^a	0 ^b
about butter price	10.4 ^b	88.0 ^a	0	25.0 ^b	25.0 ^b
about butter quality	89.6 ^a	56.0 ^b	0	37.5 ^b	50.0 ^b
Payment frequency for butter (%)					
upfront	62.5 ^a	11.8 ^c	100	12.5 ^{bc}	25.0 ^{abc}
at end of transaction	18.8 ^b	84.3 ^a	0	37.5 ^b	50.0 ^{ab}
weekly or less	18.8 ^b	3.9 ^c	0	50.0 ^{ab}	25.0 ^{abc}
Minimum butter price (ETB/kg)	181.0 ^a ± 3.8	143.3 ^c ± 3.9	200.00	192.9 ^{ab} ± 13.0	150.0 ^{bc} ± 12.3
Maximum butter price (ETB/kg)	213.3 ^a ± 4.3	209.4 ^a ± 4.7	250.00	218.6 ^a ± 14.2	187.5 ^a ± 12.5
Butter price fluctuation (ETB/kg)	32.3 ^b ± 2.8	66.1 ^a ± 4.0	50.00	25.7 ^b ± 9.5	37.5 ^{ab} ± 7.5
Selling frequency of butter (%)					
weekly	2.1 ^b	13.7 ^a	100	0 ^{ab}	0 ^{ab}
less than weekly	97.9 ^a	86.3 ^b	0	100 ^{ab}	100 ^{ab}

Note: Data in this table are only for those farmers that report to sell butter.

Mean ± standard error for the continuous variables and frequencies for the categorical variables.

^{a-c} Means and frequencies within a row with different superscripts differ ($p < 0.05$).

D. Supplementary material - Chapter 6

D.1. Names and religious symbols used in the discrete choice experiments

Table S6-1: Christian and Muslim names adopted in the choice experiment

Names referring to Christian background		Names referring to Muslim background	
Male	Female	Male	Female
Abraham	Eleni	Ali	Semira
Yisak	Sara	Mohammed	Jemilla
Michael	Weletemariam	Ahmed	Fatuma
Yared	Letegebriel	Seid	Kedija
Yohanis	Arisema	Ibrahim	Hayat
Kidus	Mariamawit	Jemal	Kerya
Gebregzabher	Eyerusalem	Yusin	Saada

Table S6-2: Christian and Muslim cartoons adopted in the choice experiment

Cartoons referring to Christian background		Cartoons referring to Muslim background	
Male	Female	Male	Female
			
			
			
			
			
			
			

D.2. Latent Class Attribute Non-Attendance model

Formally, in latent class models the probability that a respondent i chooses milk seller j in choice situation t is generated by the multinomial logit model expression:

$$Prob[y_{it} = j | class = c] = \frac{\exp(\beta'_c x_{jit})}{\sum_{j=1}^J \exp(\beta'_c x_{jit})} \quad \text{eq. 1}$$

The probability that an individual belongs to a specific segment can be expressed as follows:

$$Prob[class = c] = \frac{\exp(\alpha'_c Z_i)}{\sum_{c=1}^C \exp(\alpha'_c Z_i)} \quad \text{eq. 2}$$

Where Z_i is a vector for specific variables of the individual informative about the likelihood of a farmer's membership to a particular segment, and α is a segment specific parameter that denotes the contribution of the farmers' characteristics to the probability of a class membership.

The unconditional probability that any randomly selected respondent chooses a specific alternative, is obtained by combining the conditional probability in (1) with the segment membership probability in (2), resulting in the following equation:

$$Prob[y_{it}=j] = \sum_{c=1}^C \left(\frac{\exp(\beta'_c x_{jit})}{\sum_{j=1}^J \exp(\beta'_c x_{jit})} \right) \prod_{t=1}^T \left(\frac{\exp(\alpha'_c Z_i)}{\sum_{c=1}^C \exp(\alpha'_c Z_i)} \right) \quad \text{eq. 3}$$

D.3. Detail of latent class specification and average class membership share of the stepwise latent class attribute non-attendance approach

In the first ANA model specification six non-attendance patterns are estimated, i.e. full attendance and non-attendance of one of the five attributes. Only those non-attendance patterns found significant (i.e. full attendance, class 3 and 4 of one attribute non-attendance) were retained for the second ANA specification. These three classes were estimated in ANA model 2 together with the ten classes representing non-attendance of 2 attributes. The classes 1,8,10,11 and 16 were retained in the third ANA model and estimated together with the specifications for non-attendance for 3 attributes. This procedure was repeated for models 4 and 5.

Table S6-3: Detail of latent class specification and average class membership share of the stepwise LC ANA model

Class number	Coefficients estimated					Model ANA-1	Model ANA-2	Model ANA-3	Model ANA-4	Final ANA model
1	β_{religion}	β_{gender}	β_{supplier}	β_{distance}	β_{price}	31.93%	37.25%	37.57%	34.95%	28.03%
2	β_{religion}	β_{gender}	β_{supplier}	β_{distance}	0	0.00%	--	--	--	--
3	β_{religion}	β_{gender}	β_{supplier}	0	β_{price}	30.95%	--	--	--	--
4	β_{religion}	β_{gender}	0	β_{distance}	β_{price}	37.12%	--	--	--	--
5	β_{religion}	0	β_{supplier}	β_{distance}	β_{price}	0.00%	--	--	--	--
6	0	β_{gender}	β_{supplier}	β_{distance}	β_{price}	0.00%	--	--	--	--
7	0	0	β_{supplier}	β_{distance}	β_{price}	--	--	--	--	--
8	0	β_{gender}	β_{supplier}	β_{distance}	0	--	29.23%	17.58%	15.62%	14.90%
9	β_{religion}	0	β_{supplier}	β_{distance}	0	--	--	--	--	--
10	β_{religion}	β_{gender}	0	β_{distance}	0	--	25.56%	--	--	--
11	β_{religion}	β_{gender}	β_{supplier}	0	0	--	0.90%	--	--	--
12	β_{religion}	β_{gender}	0	0	β_{price}	--	--	--	--	--
13	β_{religion}	0	β_{supplier}	0	β_{price}	--	--	--	--	--
14	0	β_{gender}	β_{supplier}	0	β_{price}	--	--	--	--	--
15	β_{religion}	0	0	β_{distance}	β_{price}	--	--	--	--	--
16	0	β_{gender}	0	β_{distance}	β_{price}	--	7.06%	--	--	--
17	β_{religion}	β_{gender}	0	0	0	--	--	9.03%	0.92%	2.89%
18	β_{religion}	0	β_{supplier}	0	0	--	--	16.12%	--	--
19	β_{religion}	0	0	β_{distance}	0	--	--	15.25%	13.08%	11.41%
20	β_{religion}	0	0	0	β_{price}	--	--	--	--	--
21	0	β_{gender}	β_{supplier}	0	0	--	--	--	--	--
22	0	β_{gender}	0	β_{distance}	0	--	--	--	--	--
23	0	β_{gender}	0	0	β_{price}	--	--	0.71%	0.62%	0.38%
24	0	0	β_{supplier}	β_{distance}	0	--	--	--	--	--
25	0	0	β_{supplier}	0	β_{price}	--	--	--	--	--
26	0	0	0	β_{distance}	β_{price}	--	--	3.74%	3.23%	3.99%
27	β_{religion}	0	0	0	0	--	--	--	10.54%	--
28	0	β_{gender}	0	0	0	--	--	--	--	--
29	0	0	β_{supplier}	0	0	--	--	--	21.06%	27.42%
30	0	0	0	β_{distance}	0	--	--	--	--	--
31	0	0	0	0	β_{price}	--	--	--	--	--
32	0	0	0	0	0					10.98%

D.4. Measuring religiosity

Additionally, we tried to measure the intensity of belief (i.e. religiosity) amongst our respondents. We wondered whether adherence to fasting practices varies with intensity of belief. Moreover, we were curious if religiosity could explain why certain consumers self-select to co-religious milk suppliers as Allport and Ross [479] argued that individuals who are extrinsically motivated are more prejudiced than those who are intrinsically motivated.

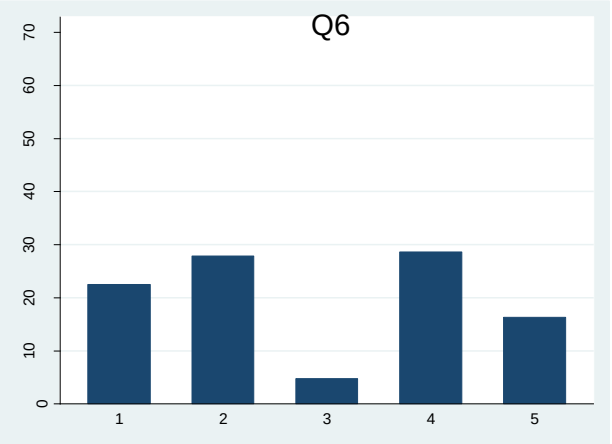
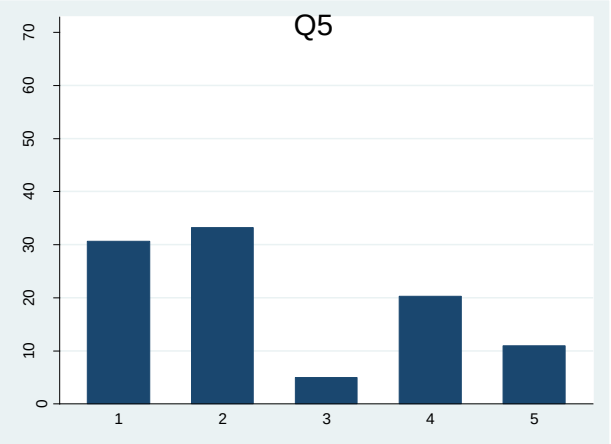
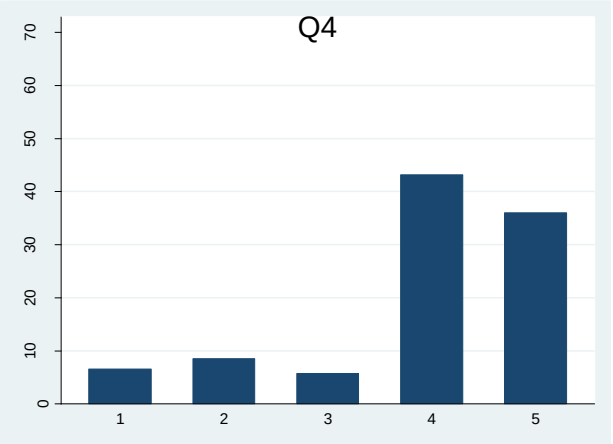
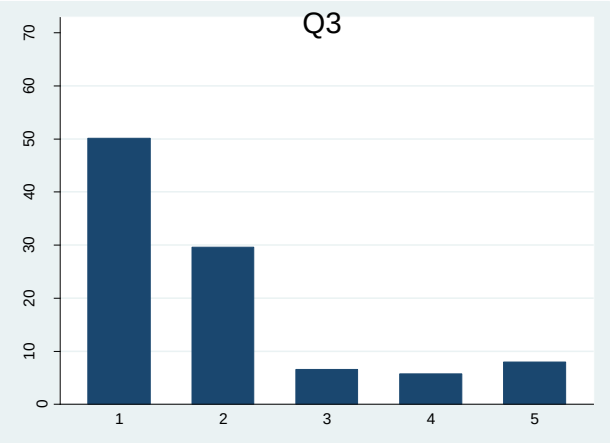
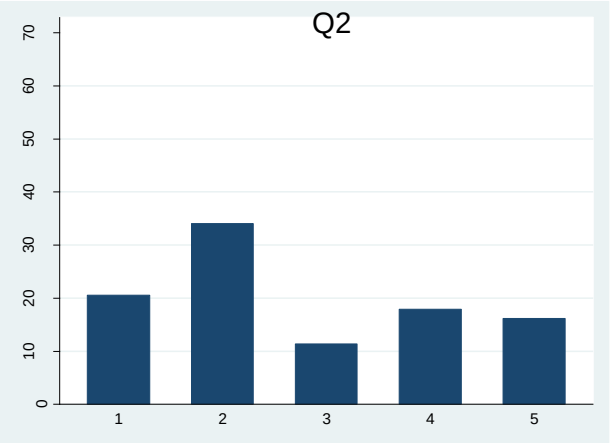
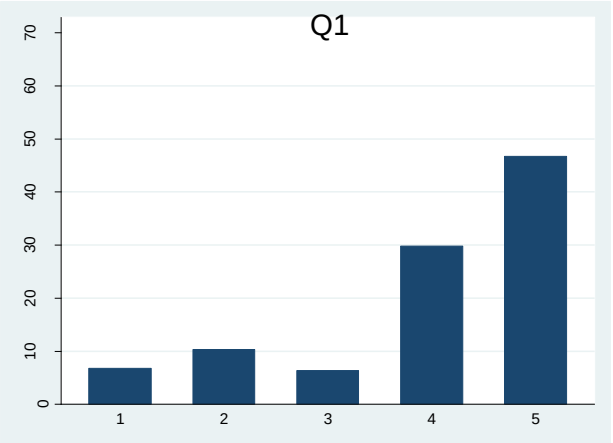
Very often religion has been instrumentalized as a combination of religious affiliation (i.e. what you believe) and religiosity (i.e. how strong you believe). Worthington et al. [480] has defined religiosity as “the degree to which a person adheres to his or her religious values, beliefs, and practices and uses them in daily life”. In economic studies, religiosity has predominantly been operationalized using behavioural measures such as attendance to religious services or other religious activities (notably religious spending), e.g. see Barro and McCleary [62], Mangelaja [481], Gruber [482], Gruber and Hungerman [483], and Mohanty [484]. Yet, more complex scales have been developed whereby respondents self-assess the strength of their belief. A downside of such self-assessments is their sensitivity to social desirability bias. One of the oldest and most commonly employed scales is the Religious Orientation Scale developed by Allport and Ross [479]. This scale measures motivation for religious behaviour rather than behaviour itself. The scale divides individuals broadly in two categories: intrinsically religious people and extrinsically religious people. The former live their religion, while the latter use their religion for their own ends [479]. The latter are engaged in religion for the sake of other objectives, which can be e.g. security, status, distraction, or being part of a religious community. The ROS has been tested and validated with several groups and within various context. The scale, which comprises several items, has been regularly updated, and we used the most recent one, i.e. the New Indices of Religious Orientation Revised scale, which has a simplified language [485].

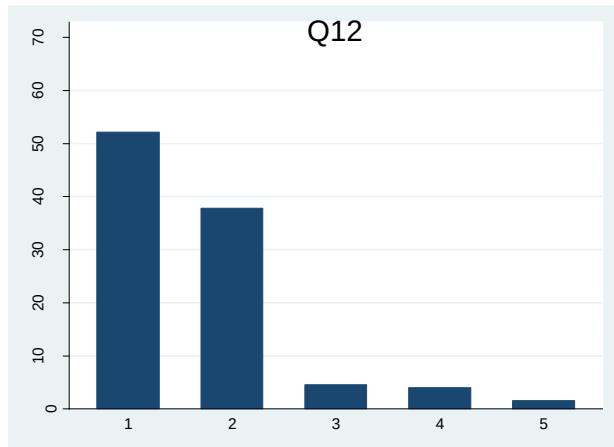
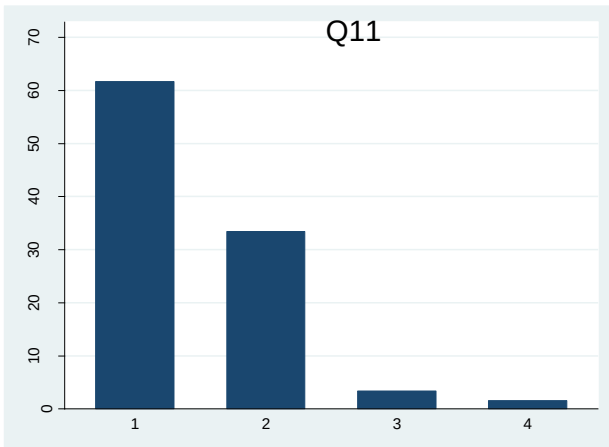
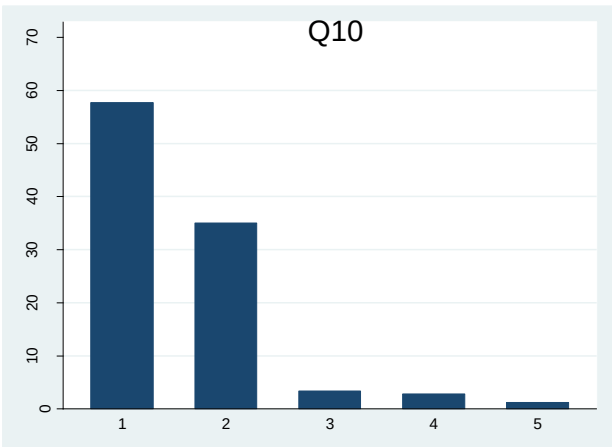
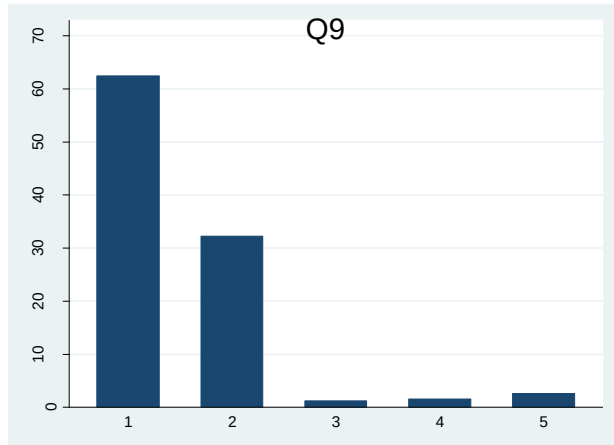
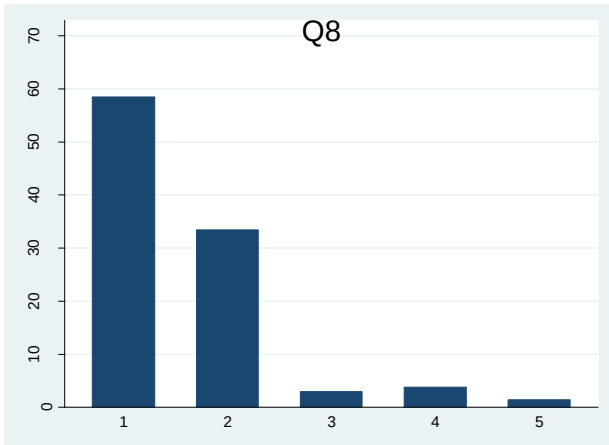
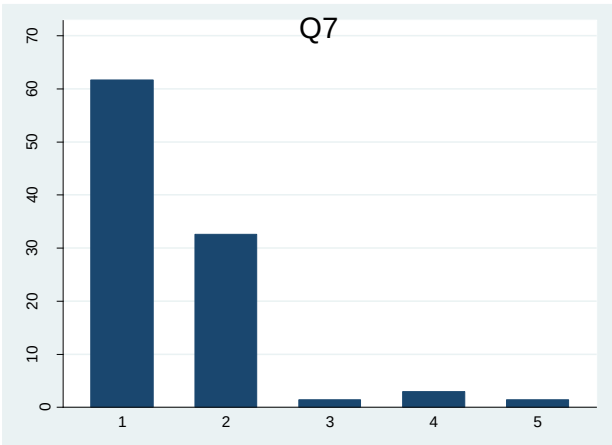
The New Indices of Religious Orientation Revised scale comprises 18 statements of which nine measure extrinsic motivation, and the other nine intrinsic motivation. Respondents need to report the extent to which they agree or disagree with each statement using a 5-item Likert scale (strongly agree, agree, not certain, disagree, strongly disagree) (Table S6-4). Both the extrinsic and intrinsic sub-scales consist of three conceptual components, the first reflecting separation (Q1-Q3) or integration (Q10-Q12) of religion from/with the rest of life, a public component (Q4-Q6 and Q13-Q15) and a personal component (Q7-Q9 and Q16-Q18). The ROS and NIROR scales have been almost exclusively tested in Western contexts, and therefore not yet validated in developing contexts. We are the first to verify whether these scales can be used as such within an African context

Table S6-4: Extrinsic and intrinsic orientation statements included in the NIROR scale and adapted to the Ethiopian context

Extrinsic orientation	Intrinsic orientation
Q1: While I believe in the Orthodox / Muslim / Protestant / Catholic faith, I feel there are more important things in my life	Q10: My Orthodox / Muslim / Protestant / Catholic faith shapes how I live my daily life
Q2: While I am an Orthodox / Muslim / Protestant / Catholic, I do not let my faith influence my daily life	Q11: I try hard to carry my Orthodox / Muslim / Protestant / Catholic belief over into all other areas of my life
Q3: Occasionally I have compromised my Orthodox / Muslim / Protestant / Catholic beliefs to fit in better with other people	Q12: My Orthodox / Muslim / Protestant / Catholic faith really shapes the way I treat people
Q4: One reason for me going to Church / Mosque is to connect with others	Q13: I allow almost nothing to prevent me from going to Church / Mosque on Sundays
Q5: A key reason to go to Church / Mosque is that it is socially enjoyable	Q4: I go to Church/ Mosque because it helps me feel close to God / Allah
Q6: I go to Church / Mosque because it helps me to feel part of a community	Q15: The Church/ Mosque is most important to me as a place to be part of God / Allah's family
Q7: One reason for me praying is that it helps me to gain relief and protection	Q16: I pray at home because it helps me be aware of God / Allah's presence
Q8: What prayer offers me most is comfort when bad things happen to me	Q17: I often read books about my religion
Q9: I pray mainly because it makes me feel better	Q18: I pray mainly because it deepens my relationship with God / Allah

First of all, we descriptively display the respondents' answers to each of the statements in Figure S8-1. We found that the answers of our respondents were highly skewed to either the left or right side. As such, 90% or more of the respondents (strongly) agreed to 10 of the 18 statements. For five statement, more than three quarter (strongly) agreed (Q1, Q3, Q4, Q13, and Q17). Only three statement (all in the extrinsic orientation dimension) showed some variation: mostly Q6 where 50% (strongly) agreed and 45% (strongly) disagreed, for the other Q2 and Q5, we found that 34% and 32% (strongly) disagreed while 55% and 64% (strongly) agreed, respectively.





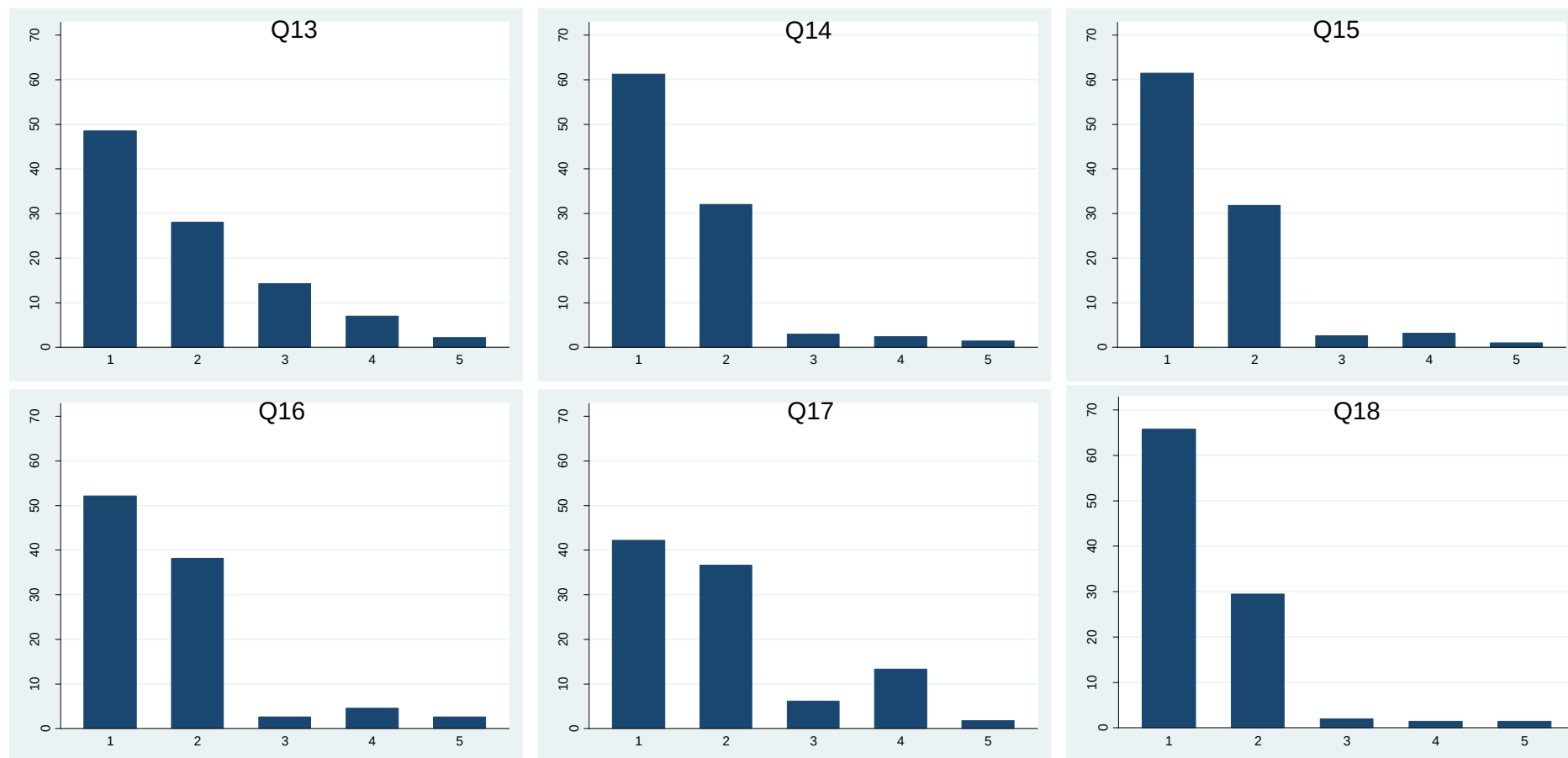


Figure S6-1: Frequency distribution of the answers to several religious orientation statements

Note: The labels on the x-axis represent the following: 1= strongly agree; 2= agree; 3= not certain; 4= disagree; 5= strongly disagree. The several statements (Q1-Q18) are summarized in Table 4.

Next, we tested the validity of the scale using an exploratory factor analysis, which consisted of a principal axis factor extraction with orthogonal rotation in order to determine the dimensions of the religious orientation in our sample. We did not retrieve the same dimensions/factors as those established in literature. Instead, we found significant overlap in several components of the scale and six items were not included in the factors we retrieved, i.e. Q1, Q2, Q3, Q8, Q14, Q17 (Table S6-5). Moreover, factor 1 and 2 we retrieved were still significantly correlated, after we used an orthogonal rotation.

Table S6-5: Retrieved factors and included items after applying exploratory factor analysis

	Included items
Factor 1	Q7 Q9 Q15 Q16
Factor 2	Q10 Q11 Q12 Q13 Q18
Factor 3	Q4 Q5 Q6

Q1, Q2, and Q3 were often defined as a paradox by our respondents because there are clearly “no more important things in life” than faith (Q1). Consequently, religion influences people’s daily life (Q2) and no compromises are made (Q3). All three items loaded very poorly on the identified factors, and were thus dropped. The items Q8 and Q14 loaded on two factors (factor 1 and 2) and therefore had to be removed as well. Finally, item Q17 was considered irrelevant for the factor analysis. A large number of our respondents was not able to read, yet many respondents claimed to go to church and listen to somebody else reading religious books. Because of the ambiguous understanding of this question, we decided to remove also Q17 from the analysis.

The factors/dimensions we retrieved are very different from the original NIROR scale. We observe overlap of the extrinsic personal, intrinsic public, and intrinsic personal components in factor 1. Moreover, in factor 2, items of all three components of the intrinsic orientation were present. Only the third factor combined the three items that are supposed to measure the extrinsic public component. During the data collection, we noted that respondents frequently confirmed to enjoy the atmosphere and social life around church, however they indicated that this was not the major reason for going to church.

The NIROR scale can thus not be used as such in the context of Ethiopian, and there is a need to develop better scales that can capture various degrees of religiosity in this context. Although we could not validate the scale, we still tested for those items we explored some response heterogeneity (i.e. Q2, Q5, and Q6) whether we could link this heterogeneity to differential probabilities of attending to the attribute religion in the choice experiment. Yet, we could not find any tendency that people scoring high or low on these extrinsic item questions were also more likely to attend to the attribute religion.

Appendix

1. Questionnaire milk shop owner(s) in Mekelle city (Chapter 2)

General information for the respondent

Good day, we are researchers from the department of Agricultural Economics of Mekelle University and Ghent University in Belgium. We are currently questioning dairy households to obtain detailed information about the dairy value chain in Mekelle.

Your participation is voluntary. You may choose not to answer any question and you may choose to stop the discussion at any time. Refusing to participate will not affect you or your family in any way. We would like you to answer as honestly as possible. We want to emphasize that your responses will be kept strict confidential. Are you willing to participate in this study?

0. No	1. Yes

By filling in this questionnaire, we are able to identify major issues and strengths of the urban and peri-urban dairy sector. This information will be used to identify possible intervention areas and solution strategies to solve critical problems. We will keep you informed of the research findings and recommendations will be shared with you once the study is completed.

Survey identification

Date (according to the European calendar)	/...../2016	
Survey carried out by	1.	Enumerator 1
	2.	Enumerator 2
	3.	Enumerator 3
	4.	Enumerator 4
	5.	Atakilt
Survey number		
Name of respondent		
Telephone number of respondent		
Location of the shop	Woreda/district	
	Kebele	
	GPS coordinates	

Note for the enumerator

The answer options displayed **should NOT be read out loud**, unless it is indicated otherwise. These options only serve as a guide for the interviewer to indicate the respondent's answer. Extra information for the enumerator is indicated in italic font style. This information **should NOT be read out loud**.

To be filled in by the enumerator after completing the questionnaire

Write down important observations/remarks/thoughts on the interview (eg interviewee was reluctant to answer the questions, you doubt whether (some) answers given by the interviewee are reliable etc)

SECTION A: HOUSEHOLD CHARACTERISTICS

Ask the respondent following questions for each person (including children, relatives, hired laborers...) living in the household's house. Include members that are living outside the household's house but send their income earned to the household.

	A.1. Name	A.2. Sex Male=0 Female=1	A.3. Age (in years)	A.4. Marital status (Code 1)	A.5. Is currently going to school? No=0 Yes=1	A.6. Highest education or qualification level attained (Code 2)	A.7. Status in the household (Code 3)	A.8. Is currently working for cash or in-kind income? No=0 Yes=1	A.9. Main occupation (Code 4)
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									

Code 1	Code 2	Code 3	Code 4
1= Single	1= No schooling	1= Household head	1= Working in the milk shop
2= Married	2= Junior primary/basis education (Grade 1-4)	2= Partner of household head	2= Livestock activities
3= Divorced/separated	3= Senior primary/ general education (Grade 5-8)	3= Child	3= Crop production
4= Widowed	4= General secondary (Grade 9-10)	4= Grandparent	4= (Agro-) industry
	5= Preparatory secondary (Grade 11-12)	5= Aunt or uncle	5= Trade
	6= Higher education/university	6= Niece or nephew	6= Retail
	7= Courses or certificates for formal training; technical or vocational training	7= Cousin	7= Government employee
	8= Church/mosque education	8= Great-grandparent	8= Retired
		9= Other family	9= Unemployed
		10= Other non-family	10= Carrying out household tasks
			11= Shop
			12= Brewing beer
			13= Petty trade
			14= Other, specify

A.10.	Religion of the household	1. Ethiopian orthodoxy	2. Protestantism	3. Catholicism	4. Islam	5. Traditional faith	6. Other, specify

SECTION C : GENERAL SHOP ACTIVITIES

C.1.	Since how long do you have the shop (in years)?	years						
C.2.	Why did you start keeping the shop? (Multiple answers are possible. If multiple answers are given, ask the respondent the level of importance and indicate this; 1= most important, 2= second most important, 3=....)		1. Family tradition	2. Earn cash income from selling milk	3. Saving/ insurance	4. Investment opportunity	5. Generate employment	6. Other, specify
		Level of importance						
C.3.	Who is the owner of the shop?	1. Household head	2. Partner of the household head	3. Household head & partner	4. Other, specify			
C.4.	Did you use hired labour for your shop in the last 12 months?	0. No			1. Yes			
C.5.	If the answer is YES to C.4., how many female laborers and/or male laborers did you hired permanently (ie from 5 days per week up to every day per week)?	1. Number of female laborers hired permanently						
		2. Number of male laborers hired permanently						
	If the answer is YES to C.4., how many female laborers and/or male laborers did you hire between 2 days per week and 4 day; 1 day per week and 1 day per month; and/or less than 1 day per month?		C.6. 2 days/week – 4 days/week	C.7. 1 day/week – 1 day/month		C.8. Less than 1 day/month		
		1. Number of female laborers hired						
		2. Number of male laborers hired						

Read out following list of activities and ask the respondent whether the activity is performed in the shop. Indicate 0 if the activity is NOT performed and 1 if the activity is performed. Then ask who is/are the responsible(s) for that activity. Indicate responsible(s) in the column "Responsible(s)" by using the accompanying code 5.

Type of activity	C.9. Is it performed? No=0 Yes=1	C.10. Responsible(s) (Code 5)
1 Buying dairy products		
6 Processing milk		
7 Selling of dairy products		

Code 5	
1= Household head	7= Uncle
2= Partner of household head	8= Niece or nephew
3= Child (boy)	9= Cousin
4= Child (girl)	10= Other family
5= Grandparent	11= Permanent hired labour
6= Aunt	12= Seasonal/temporal hired labour
	13= Other, specify

SECTION E : BUYING ACTIVITIES DAIRY PRODUCTS

Ask the respondent from which seller(s) they bought milk and/or milk products during the last 12 months.

Ask for each seller

1. the type of milk product(s) they bought from this seller. If more than 1 type was bought from that seller, fill in 1 row for each type of milk product bought.
2. the terms of agreement (whether they agreed orally or via a written contract to buy the milk product)
3. whether they agreed on certain details such as the quantity being bought, the price, the quality etc (combination of answer codes are possible, if multiple contract details are agreed on, please indicate all details agreed on and write down the corresponding codes)
4. where the milk product was bought (i.e. buying place) (ask if milk was bought in Mekelle, if this is not the case, indicate in this column the village where the product was bought)
5. which mode(s) of communication was/were used to communicate with the seller (whether it was face-to-face, via telephone, internet,...) (combination of answer codes are possible, if multiple modes are used, please indicate all modes and write down the corresponding codes)
6. how frequent you paid the seller for the milk product (up front, per transaction, daily, weekly,...)
7. which volume was bought per transaction during fastening and non-fastening days (in L or kg) on average. Indicate the unit!
8. how frequent you bought the type of milk product from that seller (occasionally, daily, weekly,...)
9. the minimum and maximum price you paid for that type of milk product from that seller (in Birr/L or Birr/kg) if that milk product was bought more than once from that seller during the last 12 months. If the milk product was only bought once, indicate the price paid in the column "Min. price" and scratch out the column "Max. price". Indicate the unit!

	E.1. Seller (Code 6)	E.2. Type of milk product bought (Code 7)	E.3. Terms of agreement written=1 unwritten=2	E.4. Contractual specification s (Code 8)	E.5. Main buying place (Code 9)	E.6. Mode(s) of communicati on (Code 10)	E.7. Frequency of payment (Code 11)	E.8. Volume bought per transaction during fastening (in L or kg) Indicate unit!	E.9. Volume bought per transaction during NON- fastening (in L or kg) Indicate unit!	E.10. Frequency of buying (Code 12)	E.11. Min price (Birr/L or Birr/kg) Indicate unit!	E.12. Max price (Birr/L or Birr/kg) Indicate unit!
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												

1= Dairy farmer	1= Fresh milk	1= Quantity supplied	1= Farm gate	1= Cell phone	1= Up front	1= Occasionally (i.e. less than once per month)
2= Cooperative/union	2= Butter	2= Mode of payment	2= Shop	2= Internet	2= At the end of each transaction	2= Daily
3= Processor	3= Cheese	3= Date of payment	3= Market	3= Letter	3= Daily	3= Weekly
4= Trader	4= Yoghurt	4= Time/ date of supply	4= Collection point	4= Face-to-face	4= Weekly	4= Every 2 weeks
5= Retailer (eg supermarket, shop, kiosk)	5= Fermented milk	5= Guaranteed purchase	5= Processing plant	5= Other, specify	5= Every 2 weeks	5= Every 3 weeks
6= Café, restaurant, hotel			6= Retailer's shop		6= Every 3 weeks	6= Monthly
7= Neighbours	6= Butter milk	6= Price	7= Café, restaurant, hotel		7= Monthly	7= Other, specify
8= Strangers	7= Whey	7= Quality	8= Other, specify		8= Other, specify	
9= Family	8= Other, specify	8= Other, specify				
10= Friends						
11= Hospital, school						
12= Other, specify						

SECTION F: GENERAL BUYING ACTIVITIES

	Can you indicate from which milk seller(s) you prefer to buy your milk and/or milk products from? <i>(Multiple answers are possible. If multiple answers are given, ask the respondent the level of preference and indicate this; 1= most preferred, 2= second most preferred, 3=...)</i> Can you also mention the reason(s) for indicating this/these preferred seller(s)? <i>(Multiple answers are possible. If multiple answers are given, ask the respondent the level of importance and write the reasons down in order of importance i.e. first number that is written down is the most important reason, second number written down the second most important reason etc.)</i> Code 13 1= Fair price 2= Regular supply 3= High volume supplied 4= Sellers located nearby the shop 5= Trust 6= Familiarity (i.e. sellers are family, friends) 7= Payment frequency 8= Other, specify	<table border="1"> <tr> <td></td> <td>F.1. Level of preference</td> <td>F.2. Reason (Code 13)</td> </tr> <tr><td>1. Dairy farmer</td><td></td><td></td></tr> <tr><td>2. Cooperative/union</td><td></td><td></td></tr> <tr><td>3. Processor</td><td></td><td></td></tr> <tr><td>4. Trader</td><td></td><td></td></tr> <tr><td>5. Retailer</td><td></td><td></td></tr> <tr><td>6. Café, resto, hotel</td><td></td><td></td></tr> <tr><td>7. Neighbors</td><td></td><td></td></tr> <tr><td>8. Strangers</td><td></td><td></td></tr> <tr><td>9. Family</td><td></td><td></td></tr> <tr><td>10. Friends</td><td></td><td></td></tr> <tr><td>11. Hospital, school</td><td></td><td></td></tr> <tr><td>12. Other, specify</td><td></td><td></td></tr> </table>		F.1. Level of preference	F.2. Reason (Code 13)	1. Dairy farmer			2. Cooperative/union			3. Processor			4. Trader			5. Retailer			6. Café, resto, hotel			7. Neighbors			8. Strangers			9. Family			10. Friends			11. Hospital, school			12. Other, specify		
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8. Strangers																																									
9. Family																																									
10. Friends																																									
11. Hospital, school																																									
12. Other, specify																																									
F.3.	In general, how would you describe your relation with all your sellers of milk and/or milk products? <i>(Show the emoticon card and read out loud the different codes and accompanying expressions. Indicate the most appropriate letter)</i> A= very good B= good C= neutral D= Not so good E= Totally not good	 A B C D E																																							
F.4.	What is going good in these relations?																																								
F.5.	What is going not so good in these relations?																																								
F.6.	What could be improved in these relations? Or: how could these relations be improved?																																								

SECTION G : SELLING ACTIVITIES DAIRY PRODUCTS

G.1.	How many dairy customers do you have?						
G.2.	To who do you sell your dairy product(s)? <i>(Multiple answers are possible. If multiple answers are given, ask the respondent the level of importance and indicate this; 1= most important, 2= second most important, 3=....)</i>					Level of importance	
		1. Strangers					
		2. Family					
		3. Friends					
		4. Neighbours					
		5. Other shops, retailers					
		6. Café, restaurant, hotel					
		7. Cooperative/union					
		8. Processor					
		9. Trader					
		10. Hospital, school					
		11. Other, specify					
G.3.	Which type of milk product(s) are sold in the shop? <i>(Multiple answers are possible. If multiple answers are given, ask the respondent the level of importance and indicate this; 1= most important milk product sold, 2= second most important, 3=....)</i>	1. Milk	2. Butter	3. Yoghurt	4. Cheese	5. Fermented milk	6. Other, specify
	What is the volume sold of different product(s) each day in the shop? Does this volume differ between fasting and non-fasting days? If yes, indicated the volumes for fastening and non-fastening days. <i>(Indicate the unit!)</i>			1. Fasting		2. Non-fasting	
		G.4. Milk		L		L	
		G.5. Butter		kg		kg	
		G.6. Yoghurt		L		L	
		G.7. Cheese		kg		kg	
		G.8. Fermented milk		L		L	

		G.9. Other, specify		
	What is the price of different product(s) sold in the shop? Does this price differ between fasting and non-fasting days? If yes, indicate the prices in fasting and non-fasting days.		1. Fasting	2. Non-fasting
		G.10. Milk	L	L
		G.11. Butter	kg	kg
		G.12. Yoghurt	L	L
		G.13. Cheese	kg	kg
		G.14. Fermented milk	L	L
		G.15. Other, specify		

SECTION H: GENERAL SELLING ACTIVITIES

	Can you indicate to which milk buyer(s) you prefer to sell your milk and/or milk products to? <i>(Multiple answers are possible. If multiple answers are given, ask the respondent the level of preference and indicate this; 1= most preferred, 2= second most preferred, 3=...)</i> Can you also mention the reason(s) for indicating this/these preferred seller(s)? <i>(Multiple answers are possible. If multiple answers are given, ask the respondent the level of importance and write the reasons down in order of importance i.e. first number that is written down is the most important reason, second number written down the second most important reason etc.)</i> Code 13 1= Fair price 2= Regular demand 3= High volume demanded 4= Buyer located nearby the shop 5= Trust 6= Familiarity (i.e. sellers are family, friends) 7= Payment frequency 8= Other, specify		F.1. Level of preference	F.2. Reason (Code 13)
		1. Dairy farmer		
		2. Cooperative/union		
		3. Processor		
		4. Trader		
		5. Retailer		
		6. Café, resto, hotel		
		7. Neighbors		
		8. Strangers		
		9. Family		
		10. Friends		
		11. Hospital, school		
		12. Other, specify		
F.3.	In general, how would you describe your relation with all your buyers of milk and/or milk products? <i>(Show the emoticon card and read out loud the different codes and accompanying expressions. Indicate the most appropriate letter)</i> A= very good B= good C= neutral D= Not so good E= Totally not good	E A B C D		
F.4.	What is going good in these relations?			
F.5.	What is going not so good in these relations?			
F.6.	What could be improved in these relations? Or: how could these relations be improved?			

SECTION I : COOPERATIVE MEMBERSHIP

I.1.	Is the shop part of a cooperative/association/group?	0. No	1. Yes
I.2.	If your answer is NO to I.1., has the shop ever been part of a cooperative/association/group in the past?	0. No	1. Yes
I.3.	If the answer is NO to I.2., did you ever think to become part of a cooperative/association/group?	0. No	1. Yes
I.4.	Why are you no part anymore/ why did you not join a cooperative/association/group? <i>(Multiple answers are possible. If multiple answers are given, ask the respondent the level of importance and indicate this; 1= most important, 2= second most important, 3=....)</i>	Level of importance	
		1. Lack of trust	
		2. No cooperative nearby	
		3. High government involvement in cooperative	
		4. High membership fee	
		5. Little advantage of joining cooperative	
		6. Bad personal experience in past with cooperative	
		7. Bas stories told by others	
		8. Unawareness of existence of a cooperative	
		9. Milk yield too low to sell milk to cooperative	
		10. Other, specify	
I.5.	If your answer is YES to I.1. or I.2., what is/was the name of the cooperative/association/group you are member of?		
I.6.	What is/was going good in the cooperative/association/group?		
I.7.	What could be/have been improved in the cooperative/association/group? Or: how could the cooperative be/have been improved?		

SECTION J : LAND

J.1.	How much land do you own (ha)?	ha				
J.2.	Who is the owner of this land?	1. Household head	2. Partner of household head	3. Household head & partner	4. Parent of household head	5. Other, specify
J.3.	How much land do you rent (ha)?	ha				
J.4.	How much land do you share with others (ha)?	ha				

SECTION K : CREDIT

K.1.	Did you ever borrow money for your shop?	0. No					1. Yes			
K.2.	If the answer is YES to K.1., from whom did you borrow this money? <i>(Multiple answers are possible. Indicate the different options if multiple answers are given)</i>	1. Micro-finance	2. NGO	3. Governm ent	4.Bank	5. Cooperati ve/ union	6. Family	7. Friends	8. Iqub/ iddir	9. Other, specify
K.3.	If the answer is YES to K.1., why did you borrow this money? <i>(Multiple answers are possible. Indicate the different options if multiple answers are given)</i>	1. To purchase the shop	2. To purchase shop equipment	3. To rent a shop				6. To pay hired labor	7. Other, specify	
K.4.	Did you already repaid the money?	0. No					1. Yes			
K.5.	In general, if you need money, to who do you turn to? <i>(Multiple answers are possible. Indicate the different options if multiple answers are given)</i>	1. Bank		2. Family		3. Friends		4. Iqub/ iddir		5. Other, specify

SECTION L: ASSET AND SERVICE OWNERSHIP

Read out following list ("Does the household has ...") and indicate whether household owns (encircle 1) or owns NOT (encircle 0) a specific asset .

		No	Yes
L.1.	Electricity	0	1
L.2.	Radio	0	1
L.3.	Television	0	1
L.4.	Refrigerator	0	1
L.5.	Mobile telephone	0	1
L.6.	Non-mobile telephone	0	1
L.7.	Bicycle	0	1
L.8.	Motorcycle/scooter	0	1
L.9.	Car/truck	0	1
L.10.	Ox	0	1
L.11.	Horse	0	1
L.12.	Donkey	0	1
L.13.	Bank account	0	1

L.14. What source of drinking water does the household uses? (If more than 1 source is used, only indicate the main drinking water source)

1.	Drinking water is piped into dwelling	8.	Drinking water from public protected spring
2.	Drinking water is piped to yard/plot	9.	Drinking water from public unprotected spring
3.	Drinking water is piped in public tap	10.	Drinking water is from surface water (river, lake, pond, stream dam)
4.	Drinking water from borehole	11.	Drinking water is rainwater
5.	Drinking water from well in residence	12.	Drinking water from bottled water
6.	Drinking water from public protected well	13.	Other, specify
7.	Drinking water from public unprotected well		

L.15. What type of toilet/latrine facilities does the household uses? (NOTE: A facility is shared once it is used by two or more households)

1.	Uses own flush toilet	7.	Uses own ventilated pit latrine
2.	Uses shared flush toilet	8.	Uses shared ventilated pit latrine
3.	Uses own pit latrine without slab	9.	Uses own composting toilet
4.	Uses own pit latrine wit slab	10.	Uses shared composting toilet
5.	Uses shared pit latrine without slab	11.	Uses bush as latrine
6.	Uses shared pit latrine wit slab	12.	Uses other type of latrine, specify

L.16. What type of flooring material is present in the household's house? *(If more than 1 type of material present, only indicate the main flooring material type)*

1.	Earth/sand	6.	Vinyl or asphalt strips
2.	Dung	7.	Ceramic tiles
3.	Wood/planks	8.	Cement
4.	Palm/bamboo	9.	Carpet
5.	Parquet or polished wood	10.	Other, specify

L.17. What type of roofing material is used for the household's house? *(If more than 1 type of material used, only indicate the main roofing material type)*

1.	Natural material roofing
2.	Corrugate iron roofing
3.	Roofing tiles
4.	Other, specify

L.18. How many rooms are used for sleeping?

1.	One
2.	Two
3.	Three or more

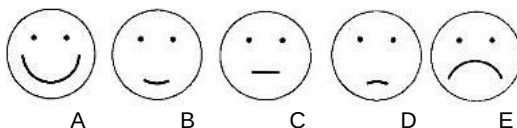
L.19. What type of cooking fuel is used by the household? *(If more than 1 type of fuel used, only indicate the main cooking fuel type)*

1.	Electricity	6.	Straw/shrubs/grass
2.	LPG/natural gas/biogas	7.	Agricultural crop
3.	Kerosene	8.	Animal dung
4.	Charcoal	9.	Other, specify
5.	Wood		

SECTION M : SOCIAL TIES

M.1.	How many relatives (i.e. family) of the household (which are living outside the household's house) are also engaged in having a milk shop?				
M.2.	How many fellow milk shop owners do know personally?				
M.3.	How many dairy product sellers do you know personally?				
M.4.	How many dairy buyers do you know personally?				
M.5.	How many people are really willing to assist the household if the household is having difficult times (eg death of household, losing job...)	1. No one	2. One or two people	3. Three or four people	4. Five or more people
	Do you or any member of your household belong to one or more of the following groups? If yes, tell me which household member is most active in the group. <i>(Read out & indicate 1 if someone of the household is member and 0 if no one is member. If you indicated 1, please write down who of the household is most active in the group using the accompanying code 25)</i> <i>Code 25</i> <i>1= Household head</i> <i>2= Partner household head</i> <i>3= Child</i> <i>4= Grandparent</i> <i>5= Aunt or uncle</i>			M.6. Membership? (0= No, 1= Yes)	M.7. Most active member (Code 25)
		1. Neighbourhood/village committee (eg agricultural bureau, woreda office)			
		2. Religious or spiritual group (eg church, mosque)			
		3. Finance, credit or savings group (eg iqub/iddir)			

SECTION N : HOUSEHOLD'S INCOME AND INCOME SOURCES

	Can you indicate how much income was generated by each activity carried out by one of the household members(*) during the last month (in Birr)? Do these activities provide a regular or an occasional income? Regular= income every week Occasional= income in some months (1-4 months) <i>(Place an "R" in the column "Frequency" if the income is regular and if the income is occasional place an "O")</i> <i>(*) i.e. every person part of the household (either living in the households' house or living outside the house but still sending part of the income earned to the household) that is participating either as consumer or producer (of income) for more than 6 months. Thus this also includes children, disabled people and old people.</i>		N.1. Amount (Birr/month)	N.2. Frequency
		1. Milk shop		
		2. Livestock activities		
		3. Crop production		
		4. (Agro-)industry		
		5. Trade		
		6. Retail		
		7. Government employee		
		8. Shop		
		9. Brewing beer		
		10. Petty trade		
		11. Pension/social insurance		
		12. Other, specify		
N.3.	What was the total income of your household in one month on average during the last 12 months (including income of all household members) (in Birr)?	Birr/month		
N.4.	Is total income of the household enough to meet the basic needs of the household (i.e. enough for your household to feed, clothe and house themselves)?	0. No		1. Yes
N.5.	How satisfied are you with the overall financial situation of your household? <i>(Show the emoticon card and read out loud the different codes and accompanying expressions. Indicate the most appropriate letter)</i> A= very satisfied B= satisfied C= neutral D= not so satisfied E= totally not satisfied			
N.6.	Is this money earned from shop activities spend on different sources than money earned from other activities?	0. No		1. Yes
N.7.	If the answer is YES to N.6., for what is the money earned from the shop activities only, used for? <i>(Multiple</i>	Level of importance		
		1. Pay school fees & material		
		2. Buy basic needs (food, cloths)		

	<i>answers are possible. If multiple answers are given, ask the respondent the level of importance and indicate this; 1= most important, 2= second most important, 3=...)</i>	3. Buy non-basic goods			
		4. Health expenditure			
		5. Savings			
		6. Loan repayment			
		7. House construction			
		8. Invest in shop			
		9. Buy shop material/equipment			
		10. Other, specify			
N.8.	Who decides on what resources the income from selling milk and/or milk products is used?	1. Household head	2. Partner of household head	3. Partner & household head	4. Other, specify

SECTION P : GENERAL QUESTIONS

P.1. Are you planning to continue your shop? Can you explain why yes or why not?

0. No	1. Yes

P.2. If you're planning to continue, will you increase your shop activities? Can you explain why yes or why not?

0. No	1. Yes

P.3. Would you recommend having a milk shop to other people (such as family or friends)? Can you explain why yes or why not?

0. No	1. Yes

End individual interview. Thank the respondent.

2. Questionnaire dairy holder(s) in Mekelle city (Chapter 5)

General information for the respondent

Good day, we are researchers from the department of Agricultural Economics of Mekelle University and Ghent University in Belgium. We are currently questioning dairy households to obtain detailed information about the dairy value chain in Mekelle. Your participation is voluntary. You may choose not to answer any question and you may choose to stop the discussion at any time. Refusing to participate will not affect you or your family in any way. We would like you to answer as honestly as possible. We want to emphasize that your responses will be kept strict confidential. Are you willing to participate in this study?

0. No	1. Yes

By filling in this questionnaire, we are able to identify major issues and strengths of the urban and peri-urban dairy sector. This information will be used to identify possible intervention areas and solution strategies to solve critical problems. We will keep you informed of the research findings and recommendations will be shared with you once the study is completed.

Survey identification

Date (according to the European calendar)	/...../2016	
Survey carried out by	6.	Enumerator 1
	7.	Enumerator 2
	8.	Enumerator 3
	9.	Enumerator 4
	10.	Atakilt
Survey number		
Name of respondent		
Telephone number of respondent		
Location of the dairy farm	Woreda/district	
	Kebele	
	GPS coordinates	

Note for the enumerator

The answer options displayed **should NOT be read out loud**, unless it is indicated otherwise. These options only serve as a guide for the interviewer to indicate the respondent's answer. Extra information for the enumerator is indicated in italic font style. This information **should NOT be read out loud**.

To be filled in by the enumerator after completing the questionnaire

The farmer operates:

<i>Entirely informal</i>	
<i>Mainly informal</i>	
<i>Entirely formal</i>	
<i>Mainly formal</i>	

(*) *Entirely informal* means that all the milk being produced (ie 100 %) is sold to buyers without making any written contract/agreement with the different buyers.

Mainly informal means that between 50 % and 99 % of the milk being produced is sold to buyers without making any written contract/agreement with the different buyers.

Entirely formal means that all the milk being produced (ie 100 %) is sold with making a written contract/agreement with the different buyers.

Mainly formal means that between 50 % and 99 % of the milk being produced is sold with making a written contract/agreement with the different buyers.

Write down important observations/remarks/thoughts on the interview (eg farmer was reluctant to answer the questions, you doubt whether (some) answers given by the farmers are reliable etc)

SECTION A: HOUSEHOLD CHARACTERISTICS

Ask the respondent following questions for each person (including children, relatives, hired laborers...) living in the household's house. Include members that are living outside the household's house but send their income earned to the household.

	A.1. Name	A.2. Sex Male=0 Female=1	A.3. Age (in years)	A.4. Marital status (Code 1)	A.5. Is currently going to school? No=0 Yes=1	A.6. Highest education or qualification level attained (Code 2)	A.7. Status in the household (Code 3)	A.8. Is currently working for cash or in-kind income? No=0 Yes=1	A.9. Main occupation (Code 4)
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									

Code 1	Code 2	Code 3	Code 4
1= Single	1= No schooling	1= Household head	1= Working on the dairy farm
2= Married	2= Junior primary/basis education (Grade 1-4)	2= Partner of household head	2= Other livestock activities (other than dairy cow)
3= Divorced/separated	3= Senior primary/ general education (Grade 5-8)	3= Child	3= Crop production
4= Widowed	4= General secondary (Grade 9-10)	4= Grandparent	4= (Agro-) industry
	5= Preparatory secondary (Grade 11-12)	5= Aunt or uncle	5= Trade
	6= Higher education/university	6= Niece or nephew	6= Retail
	7= Courses or certificates for formal training; technical or vocational training	7= Cousin	7= Government employee
	8= Church/mosque education	8= Great-grandparent	8= Retired
		9= Other family	9= Unemployed
		10= Other non-family	10= Carrying out household tasks
			11= Shop
			12= Brewing beer
			13= Petty trade
			14= Other, specify

A.10.	Religion of the household	1. Ethiopian orthodoxy	2. Protestantism	3. Catholicism	4. Islam	5. Traditional faith	6. Other, specify

SECTION B: DAIRY COW OWNERSHIP

B.1.	How many dairy cows do you own of each breed? <i>(Read out loud and indicate the number of animals which are kept for each specific breed)</i>	B.1. Begait/Barka	B.2. Other local breed(s)	B.3. Crossbreed	B.4. Pure breed	B.5. Other, specify			
B.2.	How long do you own crossbreeds/exotic dairy breeds? <i>(Write down in years)</i>	years							
B.3.	What is/are your reason(s) for having cross-breeds/exotic animals? <i>(Multiple answers are possible. If multiple answers are given, ask the respondent the level of importance and indicate this; 1= most important, 2= second most important, 3=....)</i>		1. Good quality milk	2. High milk production	3. Family tradition	4. Received from relatives/ friends	5. Received from NGO/ government	6. Milk buyers prefer milk from these breeds	7. Other, specify
		Level of importance							
B.4.	If you have local breeds, what is/are your reason(s) for having local breeds? <i>(Multiple answers are possible. If multiple answers are given, ask the respondent the level of importance and indicate this; 1= most important, 2= second most important, 3=....)</i>					Level of importance			
		1. Good quality milk							
		2. Good disease resistance							
		3. Good resistance heat stress							
		4. Low feed need							
		5. Little care needed							
		6. Cultural/ family tradition							
		7. Good for drought purpose							
		8. No other breed available							
		9. Other breeds too expensive							
		10. Received from relatives/ friends							
		11. Received from NGO/ government							
		12. Milk buyers prefer milk from these breeds							
		13. Other, specify							

SECTION C : DAIRY ACTIVITIES GENERAL

C.1.	Since how long are you engaged in dairy farming (in years)?	years							
C.2.	Why did you start keeping dairy cows? (Multiple answers are possible. If multiple answers are given, ask the respondent the level of importance and indicate this; 1= most important, 2= second most important, 3=....)		1. Family tradition	2. Earn cash income from selling milk	3. Saving/ insurance	4. Investment opportunity	5. To produce dairy products for household	6. Status symbol	7. Other, specify
		Level of importance							
C.3.	Who is the owner of the dairy farm?	1. Household head	2. Partner of the household head		3. Household head & partner		4. Other, specify		
C.4.	Did the dairy owner ever receive any training in dairy production?	0. No				1. Yes			
C.5.	Did the partner of the dairy owner ever receive any training in dairy production?	0. No				1. Yes			
C.6.	Does the dairy farm have access to livestock extension services?	0. No				1. Yes			
	If your answer is YES to C.6., mention the extension source and how often you were visited during the last 12 months.	C.7. Livestock extension agent				C.8. Number of visit(s) last year			
		1. Government							
		2. NGO							
		3. Cooperative							
		4. Private organisation							
		5. Other, specify							
C.9.	Did you use hired labour for your dairy activities in the last 12 months?	0. No				1. Yes			
C.10.	If the answer is YES to C.9., how many female laborers and/or male laborers did you hire permanently (ie from 5 days per week up to every day per week)?	1. Number of female laborers hired permanently							
		2. Number of male laborers hired permanently							
	If the answer is YES to C.9., how many female laborers and/or male laborers did you hire between 2 days per week and 4 day; 1 day per week and 1 day per month; and/or less than 1 day per month?		C.11. 2 days/week – 4 days/week		C.12. 1 day/week – 1 day/month		C.13. Less than 1 day/month		
		1. Number of female laborers hired							
		2. Number of male laborers hired							
C.14.	What is done with the manure produced?					Level of importance			
		1. Used as manure by the dairy household							

	(Multiple answers are possible. If multiple answers are given, ask the respondent the level of importance and indicate this; 1= most important, 2= second most important, 3=....)	2. Used as fuel by the dairy household	
		3. Used as plastering material for barn/house by the dairy household	
		4. Sold to farming neighbours as manure	
		5. Sold to farming neighbours as fuel	
		6. Sold to traders as manure	
		7. Sold to traders as fuel	
		8. Sold to rural farmers as manure	
		9. Sold to rural farmers as fuel	
		10. Sold to family/friends as manure	
		11. Sold to family/friends as fuel	
		12. Discarded	
		13. Other, specify	

Read out following list of activities and ask the respondent whether the activity is performed on their dairy farm. Indicate 0 if the activity is NOT performed and 1 if the activity is performed. Then ask who is/are the responsible(s) for that activity. Indicate responsible(s) in the column "Responsible(s)" by using the accompanying code 5.

Type of activity		C.15. Is it performed? No=0 Yes=1	C.16. Responsible(s) (Code 5)
1	Cutting and carrying green roughage		
2	Feeding		
3	Watering		
4	Milking		
5	Cleaning pens/barns		
6	Processing milk		
7	Selling of dairy products		
8	Selling of dairy animals		
9	Artificial insemination		
10	Bull services		
11	Purchase of feed		
12	Purchase of animals		

Code 5
1= Household head
2= Partner of household head
3= Child (boy)
4= Child (girl)
5= Grandparent
6= Aunt
7= Uncle
8= Niece or nephew
9= Cousin
10= Other family
11= Permanent hired labour
12= Seasonal/temporal hired labour
13= Other, specify

SECTION D : PRODUCTION AND DISTRIBUTION OF MILK

D.1.	How much milk do you produce on average per day during the dry season (from July to November) (in L)? And how much during the rainy/harvest season (from December to June) (in L)?	1. Rainy/harvest season	L/day		2. Dry season	L/day				
D.2.	How much of this milk that is produced each day is <u>sold</u> on average? Is this the same during the fastening and non-fastening days/periods? If not, specify for both the quantity sold in L. <i>If the quantity in L is not known by the respondent, ask the proportion of produced milk that is sold each day and write down this proportion eg 2/3, 1/2, 1/3, 1/5)</i>	1. Fastening period	L/day		2. Non-fastening	L/day				
D.3.	How much of this milk that is produced each day is <u>consumed</u> by the household on average? Is this the same during the fastening and non-fastening days/periods? If not, specify for both the proportion of produced milk that is consumed each day <i>(answer can be written down as eg 2/3, 1/2, 1/3, 1/5).</i>	1. Fastening period			2. Non-fastening					
D.4.	How do you feed the calves milk? <i>(Read out and encircle response)</i>	1. Bucket feeding	2. Suckling			3. Both				
D.5.	Do you give milk for free to family or friends?	0. No			1. Yes					
D.6.	If the answer is YES to D.5., do you frequently give milk for free to family or friends (i.e. more than once a week)? <i>If the answer is YES ask the respondent following question: how much of the milk produced each week is given for free (in proportion)? (answer can be written down eg 2/3, 1/2, 1/3, 1/5)</i>	0. No			1. Yes					
<i>If it was indicated that milk was processed in the previous table, ask questions to D.7. to D.9. If no milk is processed continue to question D.10.</i>										
D.7.	How much of the milk produced each day is <u>processed</u> on average? Is this the same during the fastening and non-fastening days/periods? If not, specify for both the proportion of produced milk that is processed each day <i>(answer can be written down as eg 2/3, 1/2, 1/3, 1/5).</i>	1. Fastening period			2. Non-fastening					
D.8.	What is/are your reason(s) for processing this milk? <i>(Multiple answers are possible. If multiple answers are given, ask the respondent the level of importance and indicate this; 1= most important, 2= second most important, 3=...)</i>		1. Own preference	2. Consumer preference	3. Longer shelf life	4. Higher market price	5. Fastening	6. Other, specify		
		Level of importance								
D.9.	What products are made on the dairy farm? <i>(Multiple answers are possible. If multiple answers are given, ask the respondent</i>		1. Cooking butter	2. Cosmetic butter	3. Cheese	4. Yoghurt	5. Fermented milk	6. Butter milk	7. Whey	8. Other, specify

	<i>the level of importance and indicate this; 1= most important, 2= second most important, 3=....)</i>	Level of importance								
D.10	Why are you not processing milk? <i>(Multiple answers are possible. If multiple answers are given, ask the respondent the level of importance and indicate this; 1= most important, 2= second most important, 3=....)</i>		1. Lack of capital	2. No processing equipment	3. No processing knowledge	4. Limited demand for processed products	5. Not interested	6. All milk is consumed and/or sold	7. Other, specify	
		Level of importance								

Quick check for reliability of milk distribution: D.2. + D.3. + D.7. may not be greater than 1!

SECTION E : SELLING ACTIVITIES DAIRY PRODUCTS

Ask the respondent to which buyer(s) they sold milk and/or milk products during the last 12 months. If they sold to cooperative/union and/or processor, ask the name of the cooperative/union and/or processor and write down this name in column E.1. together with the code.

Ask for each buyer

the type of milk product(s) they sold to this buyer. If more than 1 type was being sold to that buyer, fill in 1 row for each type of milk product sold.

the terms of agreement (whether they agreed orally or via a written contract to sell the milk product)

whether they agreed on certain details such as the quantity being sold, the price, the quality etc (combination of answer codes are possible, if multiple contract details are agreed on, please indicate all details agreed on and write down the corresponding codes)

where the milk product was sold (i.e. selling place) (ask if milk was sold in Mekelle, if this is not the case, indicate in this column the village were the product was sold)

which mode(s) of communication was/were used to communicate with the buyer (whether it was face-to-face, via telephone, internet,...) (combination of answer codes are possible, if multiple modes are used, please indicate all modes and write down the corresponding codes)

how frequent the buyer paid for the milk product (up front, per transaction, daily, weekly,...)

which volume was sold per transaction (in L or kg) on average. Indicate the unit!

how frequent they sold the type of milk product to that buyer (occasionally, daily, weekly,...)

the minimum and maximum price they received for that type of milk product from that buyer (in ETB/L or ETB/kg) if that milk product was sold more than once to that buyer during the last 12 months. If the milk product was only sold once, indicate the price received in the column "Min. price" and scratch out the column "Max. price". Indicate the unit!

[illegible]

Code 6	Code 7	Code 8	Code 9	Code 10	Code 11	Code 12
1= Trader	1= Fresh milk	1= Quantity supplied	1= Farm gate	1= Cell phone	1= Up front	1= Occasionally (i.e. less than once per month)
2= Cooperative/union	2= Butter	2= Mode of payment	2= Market	2= Internet	2= At the end of each transaction	2= Daily
3= Processor	3= Cheese	3= Date of payment	3= Collection point	3= Letter	3= Daily	3= Weekly
4= Retailer (eg supermarket, shop, kiosk)	4= Yoghurt	4= Time/ date of supply	4= Processing plant	4= Face-to-face	4= Weekly	4= Every 2 weeks
5= Café, restaurant, hotel	5= Fermented milk	5= Guaranteed purchase	5= Retailer's shop	5= Other, specify	5= Every 2 weeks	5= Every 3 weeks
6= Neighbours	6= Butter milk	6= Price	6= Café, restaurant, hotel		6= Every 3 weeks	6= Monthly
7= Strangers	7= Whey	7= Quality	7= Delivery to the buyer's house		7= Monthly	7= Other, specify
8= Family	8= Other, specify	8= Other, specify	8= Other, specify		8= Other, specify	
9= Friends						
10= Hospital, school						
11= Other, specify						

SECTION F: GENERAL SELLING ACTIVITIES

	Can you indicate to which milk buyer(s) you prefer to sell your milk and/or milk products to? (<i>Multiple answers are possible. If multiple answers are given, ask the respondent the level of preference and indicate this; 1= most preferred, 2= second most preferred, 3=...</i>) Can you also mention the reason(s) for indicating this/these preferred buyer(s)? (<i>Multiple answers are possible. If multiple answers are given, ask the respondent the level of importance and write the reasons down in order of importance i.e. first number that is written down is the most important reason, second number written down the second most important reason etc.</i>) Code 13 1= Pay good price 2= Regular demand 3= High volume demanded 4= Buyers located nearby farm 5= Trust 6= Familiarity (i.e. buyers are family, friends) 7= Payment frequency 8= Not strict on milk quality 9= Other, specify		F.1. Level of preference	F.2. Reason (Code 13)
		1. Trader		
		2. Cooperative/union		
		3. Processor		
		4. Retailer		
		5. Café, resto, hotel		
		6. Neighbors		
		7. Strangers		
		8. Family		
		9. Friends		
		10. Hospital, school		
		11. Other, specify		
F.3.	In general, how would you describe your relation with all your buyers of milk and/or milk products? (<i>Show the emoticon card and read out loud the different codes and accompanying expressions. Indicate the most appropriate letter</i>) A= very good B= good C= neutral D= Not so good E= Totally not good	 A B C D E		
F.4.	What is going good in these relations?			
F.5.	What is going not so good in these relations?			
F.6.	What could be improved in these relations? Or: how could these relations be improved?			

SECTION G : FEED USE AND PURCHASE

What type(s) of feed do you give to your animals? Can you indicate why you use a feed type? <i>(Multiple answers are possible. If multiple answers are given, ask the respondent the level of importance and write the reasons down in order of importance i.e. first number that is written down is the most important reason, second number written down the second most important reason etc.)</i> What proportion of a feed type was purchased on average during last dry season (from December to June) and last rainy/harvest season (from July to November)? <i>(Give the respondent 10 marbles and ask the respondent how much marbles represent the proportion purchased for that feed type; do this for the last dry season and rainy/harvest season respectively)</i>		G.1. Feed type (Code 14)	G.2. Reason of use (Code 15)	G.3. Proportion purchased - DRY (Code 16)	G.4. Proportion purchased – RAINY/HARVEST (Code 16)
	1				
	2				
	3				
	4				
	5				
	6				
	7				
	8				
	9				

Code 14		Code 15		Code 16
1= Green grass	12= Brewery spent grain	1= Leftovers from own production		1= One marble
2= Hay	13= Cactus	2= Leftovers from HH food		2= Two marbles
3= Cereal crop residues	14= Oil seed cakes	3= Easy available		3= Three marbles
4= Pulses crop residues	15= Fresh cultivated forages	4= Other feed types are less or unavailable		4= Four marbles
5= Oil seed crop residues	16= Dried cultivated forages	5= Healthy for the animals		5= Five marbles
6= Wheat bran	17= Molasses	6= Animals like to eat it		6= Six marbles
7= Wheat middling	18= Prepared feed mixtures	7= Increases milk production		7= Seven marbles
8= Cereal grain screenings	19= Salt	8= Cheap		8= Eight marbles
9= Oil seed screenings	20= Limestone	9= Other feed types are too expensive		9= Nine marbles
10= Pulses hulls	21= Food leftovers HH	10= Received for free from family/friends		10= Ten marbles
11= Atella	22= Other, specify	11= Exchanged with others farmers		
		12= Other, specify		

G.5.	Do you exercise urea treatment?	0. No	1. Yes
G.6.	Do you prepare multi-nutrient blocks to provide to your dairy cows?	0. No	1. Yes

Ask the respondent from which seller(s) they bought feed during the last 12 months. If they bought from cooperative/union and/or factory, ask the name of the cooperative/union and/or factory and write down this name in column G.7. together with the code.

Ask for each seller

1. the type of feed product(s) they bought from this seller. If more than 1 type was being bought from that seller, fill in 1 row for each type of feed product bought.
2. the terms of agreement (whether they agreed orally or via a written contract to buy the feed product)
3. whether they agreed on certain details such as the quantity being bought, the price, the quality etc. (combination of answer codes are possible, if multiple contract details are agreed on, please indicate all details agreed on and write down the corresponding codes)
4. where the feed product was bought (i.e. buying place)
5. from which village the feed product was sold (write down the name of that village eg Mekelle, Agula, Alamata, Maichew)
6. which mode(s) of communication was/were used to communicate with the seller (whether it was face-to-face, via telephone, internet,...) (combination of answer codes are possible, if multiple modes are used, please indicate all modes and write down the corresponding codes)
7. how frequent you paid the seller for the feed product (up front, per transaction, daily, weekly,...)
8. which volume was bought per transaction on average. Specify and indicate the unit!
9. how frequent you bought the type of feed product from that seller (occasionally, daily, weekly,...)
10. the minimum and maximum price paid for that feed product type to that seller (in ETB) if that feed product was bought more than once from that seller during the last 12 months. If the feed product was bought only once from that seller, indicate the price paid in the column "Min. price" and scratch out the column "Max. price". Specify and indicate the unit!

[illegible]

Code 17	Code 18		Code 19	Code 20	Code 21	Code 22	Code 23
1= Rural farmers	1= Green grass	12= Brewery spent grain	1= Quantity supplied	1= Market	1= Cell phone	1= Up front	1= Occasionally (i.e. less than once per month)
2= Neighbouring farmers	2= Hay	13= Cactus	2= Mode of payment	2= At the selling farmer gate	2= Internet	2= At the end of each transaction	2= Daily
3= Friends	3= Cereal crop residues	14= Oil seed cakes	3= Date of payment	3= At the own farm-gate	3= Letter	3= Weekly	3= Weekly
4= Family	4= Pulses crop residues	15= Fresh cultivated forages	4= Time/ date of supply	4= Cooperative/ union plant	4= Face-to-face	4= Every 2 weeks	4= Every 2 weeks
5= Traders	5= Oil seed crop residues	16= Dried cultivated forages	5= Guaranteed supply of feed purchased	5= Compound feed mill plant	5= Other, specify	5= Every 3 weeks	5= Every 3 weeks
6= Cooperative/ union	6= Wheat bran	17= Molasses	6= Price	6= Flour mill plant		6= Monthly	6= Monthly
7= Compound feed mills	7= Wheat middling	18= Prepared feed mixtures	7= Quality	7= Oil seed processing plant		7= Other, specify	7= Few times a year
8= Flour mills	8= Cereal grain screenings	19= Salt	8= Other, specify	8= Brewery plant			8= Other, specify
9= Oil seed processing plants	9= Oil seed screenings	20= Limestone		9= Sugarcane processing plant			
10= Brewery	10= Pulses hulls	21= Other, specify		10= Shop			
11= Sugarcane processing plant	11= Atella			11= Other, specify			
12= Retailer							
13= Other, specify							

G.19.	What type of water source do you use as drinking water for your dairy cows? (<i>Only indicate one source; however if two sources were equally used, then indicate the two</i>)	1. River	2. Dam/pond	3. Borehole/well	4. Spring	5. Pipe water	6. Rain water	7. Other, specify

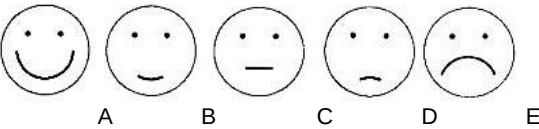
SECTION H : GENERAL FEED PURCHASE ACTIVITIES

	Can you indicate from which feed sellers you prefer to purchase feed from? <i>(Multiple answers are possible. If multiple answers are given, ask the respondent the level of preference and indicate this; 1= most preferred, 2= second most preferred, 3=...)</i> Can you also mention the reason(s) for indicating these preferred sellers? <i>(Multiple answers are possible. If multiple answers are given, ask the respondent the level of importance and write the reasons down in order of importance i.e. first number that is written down is the most important reason, second number written down the second most important reason etc.)</i> Code 24 1= Fair price 2= Regular supply 3= High volume supplied 4= Good quality 5= Sellers located/active in an area nearby farm 6= Trust 7= Familiarity (i.e. sellers are family, friends) 8= Purchase on credit 9= Other, specify	<table border="1"> <thead> <tr> <th></th> <th>H.1. Level of preference</th> <th>H.2. Reason (Code 24)</th> </tr> </thead> <tbody> <tr><td>1. Rural farmers</td><td></td><td></td></tr> <tr><td>2. Neighboring farmers</td><td></td><td></td></tr> <tr><td>3. Friends</td><td></td><td></td></tr> <tr><td>4. Family</td><td></td><td></td></tr> <tr><td>5. Traders</td><td></td><td></td></tr> <tr><td>6. Cooperative/union</td><td></td><td></td></tr> <tr><td>7. Compound feed mills</td><td></td><td></td></tr> <tr><td>8. Flour mills</td><td></td><td></td></tr> <tr><td>9. Oil seed processing plants</td><td></td><td></td></tr> <tr><td>10. Brewery</td><td></td><td></td></tr> <tr><td>11. Sugercane processing plant</td><td></td><td></td></tr> <tr><td>12. Retailer</td><td></td><td></td></tr> <tr><td>13. Other, specify</td><td></td><td></td></tr> </tbody> </table>		H.1. Level of preference	H.2. Reason (Code 24)	1. Rural farmers			2. Neighboring farmers			3. Friends			4. Family			5. Traders			6. Cooperative/union			7. Compound feed mills			8. Flour mills			9. Oil seed processing plants			10. Brewery			11. Sugercane processing plant			12. Retailer			13. Other, specify		
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H.3.	In general, how would you describe your relation with all your feed providers? <i>(Show the emoticon card and read out loud the different codes and accompanying expressions. Indicate the most appropriate letter)</i> A= very good B= good C= neutral D= Not so good E= Totally not good	 E A B C D																																										
H.4.	What is going good in these relations?																																											
H.5.	What is going not so good in these relations?																																											

H.6.	What could improve in these relations? Or: how could these relations be improved?	

SECTION I : COOPERATIVE MEMBERSHIP

I.1.	Is the dairy farm owner currently member of a cooperative?	0. No	1. Yes
I.2.	If your answer is NO to I.1., has the dairy farm owner ever been member of a cooperative in the past?	0. No	1. Yes
I.3.	If the answer is NO to I.2., did you ever think to become a member of a cooperative? <i>(If the answer is NO, please proceed to Section J; if the answer is YES, complete the following questions).</i>	0. No	1. Yes
I.4.	If your answer is YES to I.2. or I.3., why are you no member anymore/ why did you not join a cooperative? <i>(Multiple answers are possible. If multiple answers are given, ask the respondent the level of importance and indicate this; 1= most important, 2= second most important, 3=....)</i>		Level of importance
		1. Lack of trust	
		2. No cooperative nearby	
		3. High government involvement in cooperative	
		4. High membership fee	
		5. Little advantage of joining cooperative	
		6. Bad personal experience in past with cooperative	
		7. Bas stories told by others	
		8. Unawareness of existence of a cooperative	
		9. Milk yield too low to sell milk to cooperative	
	10. Other, specify		
I.5.	If your answer is YES to I.1. or I.2., what is/was the name of the cooperative you are member of?		
I.6.	When did you join the cooperative? <i>(write down year according to the European calendar)</i>		
I.7.	Do/did you pay a membership fee?	0. No	1. Yes
I.8.	If the answer is YES to I.7., how much do/did you pay each month in ETB on average?	ETB/month	
I.9.	Do/did you have a share in the cooperative?	0. No	1. Yes
I.10.	If the answer is YES to I.9., do you know how much money your share is/was worth in ETB?	ETB	

I.11.	Why did you join the cooperative? <i>(Multiple answers are possible. If multiple answers are given, ask the respondent the level of importance and indicate this; 1= most important, 2= second most important, 3=...)</i>		Level of importance
		1. Good milk price	
		2. More market access	
		3. Provide guaranteed outlet (market)	
		4. (Better) access to inputs/ services	
		5. Provide technical assistance	
		6. Provide market information	
		7. Timely payment	
		8. Collect and sell the milk	
		9. Other, specify	
I.12.	Which of the following services/inputs does/did the cooperative provide to its members? <i>(Read out & indicate 0 if service/input is NOT provided and 1 if it is provided)</i>		Provided? (0= No, 1= Yes)
		1. Feed	
		2. Veterinary services	
		3. AI services	
		4. Credit	
		5. Extension/ training	
		6. Milk quality control	
		7. Milk processing	
		8. Marketing dairy products	
		9. Other, specify	
I.13.	Are/were you part of the management board?	0. No	1. Yes
I.14.	Are/were you involved in the decision making process of the cooperative?	0. No	1. Yes
I.15.	How do/did you feel about your membership within the cooperative? <i>(Show the emoticon card and read out loud the different codes and accompanying expressions. Indicate the most appropriate letter)</i> A= very good B= good C= neutral D= Not so good E= Totally not good		
I.16.	NOTE: ask following question only if the answer to the previous question was C, D or E. It seems that you are/were not that satisfied with your membership, what is/are, was/were the reason(s) for this? <i>(Multiple answers are possible. If multiple answers are given, ask the respondent the level of importance and indicate this; 1= most important, 2= second most important, 3=...)</i>		Level of importance
		1. Lack of trust	
		2. Limited influence in decision-making	
		3. Low price for milk/milk products	
		4. Limited intake capacity	
		5. Delayed payments	
		6. Government involvement in cooperative	
		7. Inadequate/ineffective offered services/inputs	
		8. Corruption	
		9. Other, specify	

I.17.	What is/was going good in the cooperative?	
I.18.	What could be/have been improved in the cooperative? Or: how could the cooperative be/have been improved?	

SECTION J : LAND

J.1.	How much land do you own for crop cultivation (ha)?	ha				
J.2.	Who is the owner of this land for crop cultivation?	1. Household head	2. Partner of household head	3. Household head & partner	4. Parent of household head	5. Other, specify
J.3.	How much land do you rent for crop cultivation (ha)?	ha				
J.4.	How much land do you share for crop cultivation with others (ha)?	ha				
J.5.	How much pasture land do you own (ha)?	ha				
J.6.	Who is the owner of this pasture land?	1. Household head	2. Partner of household head	3. Household head & partner	4. Parent of household head	5. Other, specify
J.7.	How much pasture land do you rent (ha)?	ha				
J.8.	How much pasture land do you share with others (ha)?	ha				
J.9.	Is the pasture land you own/rent/share, used for grazing your dairy cows or to cut and carry the vegetation?	1. Grazing			2. Cut and carry	
J.10.	How much land do you own for keeping your dairy cows (including the housing) (ha)?	ha				
J.11.	Who is the owner of this land you use for keeping your dairy cows?	1. Household head	2. Partner of household head	3. Household head & partner	4. Parent of household head	5. Other, specify
J.12.	How much land do you rent for keeping your dairy cows (including the housing) (ha)?	ha				
J.13.	How much land do you share for keeping your dairy cows (including the housing) (ha)?	ha				

SECTION K : CREDIT

K.1.	Did you ever borrow money for your dairy activities?	0. No					1. Yes				
K.2.	If the answer is YES to K.1., from whom did you borrow this money? <i>(Multiple answers are possible. Indicate the different options if multiple answers are given)</i>	1. Micro-finance	2. NGO	3. Govern-ment	4.Bank	5. Cooperati-ve/ union	6. Family	7. Friends	8. Iqub/ iddir	9. Other, specify	
K.3.	If the answer is YES to K.1., why did you borrow this money? <i>(Multiple answers are possible. Indicate the different options if multiple answers are given)</i>	1. To purchase animal	2. To purchase farm equipment		3. To purchase land		4. To purchase forage seeds		5. To purchase feed	6. To pay hired labor	7. Other, specify
K.4.	Did you already repaid the money?	0. No					1. Yes				
K.5.	In general, if you need money, to who do you turn to? <i>(Multiple answers are possible. Indicate the different options if multiple answers are given)</i>	1. Bank			2. Family		3. Friends		4. Iqub/ iddir		5. Other, specify

SECTION L: ASSET AND SERVICE OWNERSHIP

Read out following list ("Does the household has ...") and indicate whether household owns (encircle 1) or owns NOT (encircle 0) a specific asset .

		No	Yes
L.1.	Electricity	0	1
L.2.	Radio	0	1
L.3.	Television	0	1
L.4.	Refrigerator	0	1
L.5.	Mobile telephone	0	1
L.6.	Non-mobile telephone	0	1
L.7.	Bicycle	0	1
L.8.	Motorcycle/scooter	0	1
L.9.	Car/truck	0	1
L.10.	Ox	0	1
L.11.	Horse	0	1
L.12.	Donkey	0	1
L.13.	Bank account	0	1

L.14. What source of drinking water does the household uses? (If more than 1 source is used, only indicate the main drinking water source)

1.	Drinking water is piped into dwelling	8.	Drinking water from public protected spring
2.	Drinking water is piped to yard/plot	9.	Drinking water from public unprotected spring
3.	Drinking water is piped in public tap	10.	Drinking water is from surface water (river, lake, pond, stream dam)
4.	Drinking water from borehole	11.	Drinking water is rainwater
5.	Drinking water from well in residence	12.	Drinking water from bottled water
6.	Drinking water from public protected well	13.	Other, specify
7.	Drinking water from public unprotected well		

L.15. What type of toilet/latrine facilities does the household uses? (NOTE: A facility is shared once it is used by two or more households)

1.	Uses own flush toilet	7.	Uses own ventilated pit latrine
2.	Uses shared flush toilet	8.	Uses shared ventilated pit latrine
3.	Uses own pit latrine without slab	9.	Uses own composting toilet
4.	Uses own pit latrine wit slab	10.	Uses shared composting toilet
5.	Uses shared pit latrine without slab	11.	Uses bush as latrine
6.	Uses shared pit latrine wit slab	12.	Uses other type of latrine, specify

L.16. What type of flooring material is present in the household's house? (If more than 1 type of material present, only indicate the main flooring material type)

1.	Earth/sand	6.	Vinyl or asphalt strips
2.	Dung	7.	Ceramic tiles
3.	Wood/planks	8.	Cement
4.	Palm/bamboo	9.	Carpet
5.	Parquet or polished wood	10.	Other, specify

L.17. What type of roofing material is used for the household's house? (If more than 1 type of material used, only indicate the main roofing material type)

1.	Natural material roofing
2.	Corrugate iron roofing
3.	Roofing tiles
4.	Other, specify

L.18. How many rooms are used for sleeping?

1.	One
2.	Two
3.	Three or more

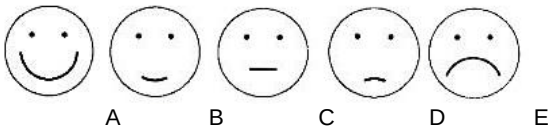
L.19. What type of cooking fuel is used by the household? (If more than 1 type of fuel used, only indicate the main cooking fuel type)

1.	Electricity	6.	Straw/shrubs/grass
2.	LPG/natural gas/biogas	7.	Agricultural crop
3.	Kerosene	8.	Animal dung
4.	Charcoal	9.	Other, specify
5.	Wood		

SECTION M : SOCIAL TIES

M.1.	How many relatives (i.e. family) of the household (which are living outside the household's house) are also engaged in dairy farming?				
M.2.	How many fellow dairy farmers do know personally?				
M.3.	How many feed sellers do you know personally?				
M.4.	How many dairy buyers do you know personally?				
M.5.	How many people are really willing to assist the household if the household is having difficult times (eg death of household, losing job...)	1. No one	2. One or two people	3. Three or four people	4. Five or more people
	Do you or any member of your household belong to one or more of the following groups? If yes, tell me which household member is most active in the group. <i>(Read out & indicate 1 if someone of the household is member and 0 if no one is member. If you indicated 1, please write down who of the household is most active in the group using the accompanying code 25)</i>			M.6. Membership? (0= No, 1= Yes)	M.7. Most active member (Code 25)
		1. Neighbourhood/village committee (eg agricultural bureau, woreda office)			
		2. Religious or spiritual group (eg church, mosque)			
		3. Finance, credit or savings group (eg iqub/iddir)			
Code 25 1= Household head 2= Partner household head 3= Child 4= Grandparent 5= Aunt or uncle					

SECTION N : HOUSEHOLD'S INCOME AND INCOME SOURCES

	Can you indicate how much income was generated by each activity carried out by one of the household members(*) during the last month (in ETB)? Do these activities provide a regular or an occasional income? Regular= income every week Occasional= income in some months (1-4 months) <i>(Place an "R" in the column "Frequency" if the income is regular and if the income is occasional place an "O")</i> <i>(*) i.e. every person part of the household (either living in the households' house or living outside the house but still sending part of the income earned to the household) that is participating either as consumer or producer (of income) for more than 6 months. Thus this also includes children, disabled people and old people.</i>		N.1. Amount (ETB/month)	N.2. Frequency
		1. Dairy cow production		
		2. Other livestock activities (other than dairy cows)		
		3. Crop production		
		4. (Agro-)industry		
		5. Trade		
		6. Retail		
		7. Government employee		
		8. Shop		
		9. Brewing beer		
		10. Petty trade		
		11. Pension/social insurance		
		12. Other, specify		
N.3.	What was the total income of your household in one month on average during the last 12 months (including income of all household members) (in ETB)?	ETB/month		
N.4.	Is total income of the household enough to meet the basic needs of the household (i.e. enough for your household to feed, clothe and house themselves)?	0. No		1. Yes
N.5.	How satisfied are you with the overall financial situation of your household? <i>(Show the emoticon card and read out loud the different codes and accompanying expressions. Indicate the most appropriate letter)</i> A= very satisfied B= satisfied C= neutral D= not so satisfied E= totally not satisfied			
N.6.	Is this money earned from dairy activities spend on different sources than money earned from other activities?	0. No		1. Yes
N.7.	If the answer is YES to N.6., for what is the money earned from the dairy activities only, used for? <i>(Multiple answers are possible. If multiple answers are given, ask the respondent the</i>	Level of importance		
		1. Pay school fees & material		
		2. Buy basic needs (food, cloths)		
		3. Buy non-basic goods		

	<i>level of importance and indicate this; 1= most important, 2= second most important, 3=...</i>	4. Health expenditure			
		5. Savings			
		6. Loan repayment			
		7. House construction			
		8. Invest in dairy farm			
		9. Buy dairy farm inputs			
		10. Other, specify			
N.8.	Who decides on what resources the income from selling milk and/or milk products is used?	1. Household head	2. Partner of household head	3. Partner & household head	4. Other, specify

SECTION O: MONTHLY EXPENDITURES ON DAIRY FARM INPUTS

O.1.	How much money did you spend on purchasing drugs and medication for your dairy cows during the last 12 months on average?	ETB	
O.2.	How much money did you spend on paying a veterinarian/artificial inseminator for your dairy cows during the last 12 months on average?	ETB	
O.3.	How much money did you spend monthly on renting land for keeping your dairy cows during the last 12 months on average?	ETB/month	
O.4.	How much money did you spend monthly on purchasing feed on average (in ETB) during the last dry season (from December to June) and the last rainy/harvest season (from July to November)?	1. Dry season	ETB/month
		2. Rainy/harvest season	ETB/month
O.5.	How much money did you spend monthly on paying hired labor for your dairy cows during the last 12 months on average?	ETB/month	

SECTION P : GENERAL QUESTIONS

P.1. Suppose you would not have dairy cows and you were not practicing any dairy production activities. Would the consumption of dairy products within your household stay the same, increase or decrease? *(Place an "X" in the corresponding row)*

1. Stay the same	
2. Increase	
3. Decrease	

P.2. Is there a feed shortage problem?

0. No	1. Yes

P.3. If the answer is YES to P.2. how do you try to bridge periods of feed insecurity? *(Multiple answers are possible. If multiple answers are given, ask the respondent the level of importance and indicate this; 1= most preferred, 2= second most preferred, 3=...)*

	Level of importance
1. Destocking	
2. Renting grass land	
3. Storing feed	
4. Transferring stock to other people	
5. Planting forage	
6. Asking relatives feed for free	
7. Exchanging goods/services with others for feed	
8. Doing nothing	
9. Other, specify	

P.4. Is the answer is YES to P.2., which interventions are needed, according to you, to overcome these shortage problems? And who should be responsible for these interventions?

P.5. Are you planning to continue your dairy activities? Can you explain why yes or why not?

0. No	1. Yes

P.6. If you're planning to continue, will you increase your dairy activities? Can you explain why yes or why not?

0. No	1. Yes

P.7. Would you recommend dairy farming to other people (such as family or friends)? Can you explain why yes or why not?

0. No	1. Yes

End individual interview. Thank the respondent.

3. Questionnaire milk producers and consumers in Mekelle city (Chapter 6 and 7)

1. INTRODUCTION

Q1.1 Enumerator

- ☐ Desu
- ☐ Mulu

Q1.2 Student

- ☐ Anna
- ☐ Svenja

Q1.3 Date

Q1.4 Respondent number of the day

Q1.5 Inform Consent

Dear participant,

WELCOME to our survey! We are researchers from the department of Agricultural Economics of Ghent University in Belgium. In this questionnaire, we would like to ask you questions on your **household's milk consumption, production and purchase**. Your participation to this study will give us more insight in how the dairy market functions in Ethiopia.

The survey will take about **20 minutes** to complete.

Your participation is **entirely voluntary** and you are under no obligation to participate. Refusing to participate will not affect you or your family in any way. We would like you to answer as honestly as possible. There are **no right or wrong answers**. We want to emphasize that your responses will be kept strict confidential and processed **anonymously**.

If you would have further questions or comments about this study, please contact:

Eline D'Haene
eline.dhaene@ugent.be

Are you willing to participate in this study?

- ☐ Yes
- ☐ No

Skip To: End of Survey If Q1.5 = No

Q1.6 How did you hear about the survey?

- ☐ Friends
- ☐ Family
- ☐ Random bystanders/individuals
- ☐ I didn't hear about it
- ☐ Other

Q1.7 In which sub-city do you live?

- ☐ Ayder
- ☐ Adi Haqi
- ☐ Hawelti
- ☐ Hadnet
- ☐ Quiha
- ☐ Semien
- ☐ Kedamay Weyane
- ☐ I live outside Mekelle

Q1.8 How old are you?

Skip To: End of Survey If Condition: Q1.8 Is Less Than 18. Skip To: End of Survey.

Q1.9 Male/female?

- ☐ Male
- ☐ Female

Q1.10 Are you the main responsible for purchasing food within your household meaning that you do the shopping?

- ☐ Yes
- ☐ No

Display This Question:

If Q1.10= No

Q1.11 How often do you purchase food for your household compared to the main responsible that is doing the shopping.

- ☐ As often as the main responsible
- ☐ Less often as the main responsible
- ☐ Never

Q1.12 Does the household buy any milk or other dairy products (e.g. butter, ayib) from others?

- ☐ Yes
- ☐ No never, milk and dairy products are all produced within the household or received from others

Skip To: Q1.14 If Q1.12 = No never, milk and dairy products are all produced within the household or received from others

Q1.13 Does the household produce its own milk?

- ☐ Yes
- ☐ No

Skip To: Q1.18 If Q1.13 = No

Q1.14 Is (part of) this produced milk sold to others?

- ☐ Yes
- ☐ No

Display This Question:

If Q1.12 = No never, milk and dairy products are all produced within the household or received from others

Or Q.13 = Yes

Q1.15 On average, how much of the milk that is consumed within the household comes from own production?

0= No milk is produced within the household

50= half of the milk that is consumed within the household comes from own production

100= all the milk that is consumed within the household comes from own production

0 10 20 30 40 50 60 70 80 90 100



Display This Question:

If Q.14= Yes

Q1.16 How often does the household **sell** milk to others?

- ☐ Daily
- ☐ 4-5 times a week
- ☐ 2-3 times a week
- ☐ Once a week
- ☐ 1-2 times a month

Display This Question:
If Q.14 = Yes

Q1.17 To who do you **sell** your milk to?

Rank the buyer types below according to the frequency you sell your milk to them.

This means that the buyer you indicate with number 1 should be the buyer to whom you sell your milk most often to, 2 means that this buyer is the second most important buyer et cetera.

If you have 2 types of buyers to whom you sell your milk equally frequently to, you can give both the same number.

	1	2	3	4	5
Neighbours	☐	☐	☐	☐	☐
Family	☐	☐	☐	☐	☐
Friends	☐	☐	☐	☐	☐
Trader	☐	☐	☐	☐	☐
Milk shop	☐	☐	☐	☐	☐
Café/restaurant	☐	☐	☐	☐	☐
Processing plant	☐	☐	☐	☐	☐
Cooperative	☐	☐	☐	☐	☐
Strangers	☐	☐	☐	☐	☐

Display This Question:
If Q1.12 = Yes

Q1.18 How often does the household **purchase** milk?

- ☐ Daily
- ☐ 4-5 times a week
- ☐ 2-3 times a week
- ☐ Once a week
- ☐ 1-2 times a month

Display This Question:
If Q1.12 = Yes

Q1.19 On average, how much of the milk that is consumed within the household comes from purchase?

0= No milk is purchased at all

50= half of the milk that is consumed within the household comes from purchase

100= all the milk that is consumed within the household comes from purchase

	0	10	20	30	40	50	60	70	80	90	100

Display This Question:
If Q1.12 = Yes

Q1.20 From which type of buyer do you **purchase** your milk?

Rank the seller types below according to the frequency you buy your milk from them.

This means that the seller you indicate with number 1 should be the seller from whom you buy your milk most often from, 2 means that this seller is the second most important seller et cetera.

If you have 2 types of sellers from whom you buy your milk equally frequently from, you can give both the same number.

	1	2	3	4	5
Neighbours	☐	☐	☐	☐	☐
Family	☐	☐	☐	☐	☐
Friends	☐	☐	☐	☐	☐
Trader	☐	☐	☐	☐	☐
Milk shop	☐	☐	☐	☐	☐
Café/restaurant	☐	☐	☐	☐	☐
Cooperative	☐	☐	☐	☐	☐
Strangers	☐	☐	☐	☐	☐

2. MILK CONSUMPTION, PRODUCTION AND SOURCING STRATEGIES

Q2.1

Over the past one week (7 days), did you or others in your household consume any **liquid** milk (excluding milk creamer/powder)? Include milk both consumed communally in the household and that consumed separately by individual household members.

- ☐ Yes
☐ No

Skip To: End of Block If Q2.1 = No

Q2.2 How much of this milk consumed in the past week came from purchase (in litre), own production (in litre), and/or gifts and other sources (in litre)?

If no milk came from a particular source, you may just indicate 0 e.g. if all the milk that was consumed in the past week was coming from purchase, you may put 0 in the box of own production and gifts and other sources.

The total you get in the end should match the total quantity of milk which was consumed by the household in the past week.

	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Litre(s) coming from purchase							
Litre(s) coming from own production							
Litre(s) coming from gifts and other sources							

Display This Question:

If Q2.2 of purchase is >0

Q2.3 How much did the household spend for this milk that you bought in the past week (in Birr)?

Display This Question:

If Q1.13 = Yes

Or Q1.12 = No never, milk and dairy products are all produced within the household or received from others

Q2.4 How many cattle for milk are owned by the household?

Cows (has had at least 1 calf) : _____

Calves : _____

Total : _____

Display This Question:

If Q1.13 = Yes

Or Q1.12 = No never, milk and dairy products are all produced within the household or received from others

Q2.5 What is the average quantity of milk produced per day per cow in litres?

3. DEMOGRAPHICS

Q3.1

In the following part, we would like some information about you and the people who **live in your house**. Exclude family that is NOT living in the house.

How many **servants** live in your house?

If you have no servants, write down 0.

Q3.2 How many **family members** live in your house?

If you alone live in the house, write down 1.

Display This Question:

If Q3.2 Is Greater Than 1

Q3.3 How many children does the household have?

If the household does not have any children, please fill in 0.

Display This Question:

If Q3.2 Is Greater Than 1

Q3.4 How many children go to school/college/university?

Q3.5 Fill in the following grid for the household head.

	Is the household head male or female?	What is the age of the household head in years since his/her last birthday?
		Age in years
Household head	▼ Female ... Male	

Q3.6 Click to write the question text

	What is the highest education or qualification the household head completed?	What is the marital status of the household head?	Is the household head working for income?
Household head	▼ No schooling ... Above Bachelor's degree (e.g. Master, PhD)	▼ Single ... Widowed	▼ Yes ... No

Display This Question:
If Q3.2 Is Equal to 1

Q3.7 What is your profession?

Display This Question:
If Q3.2 Is Equal to 1

Q3.8 How much cash income do you earn in 1 month on average in Birr? 1 month = 30 days

Display This Question:
If Q3.2 Is Equal to 1

Q3.9 Do you also earn in-kind income?

In-kind income are **NON-cash payments** for services you render to others.

These non-cash payments can be food, right to use the land of someone else to farm etc.

- ☐ Yes
- ☐ No

Display This Question:
If Q3.2 Is Greater Than 1

Q3.10 What is the profession of the household member that brings in most of the money in the household?

Display This Question:
If Q3.2 Is Greater Than 1

Q3.11 How many of the family members in the household work for income?

Include yourself in the number **if you are also working for income.**

Display This Question:
If Q3.2 Is Greater Than 1

Q3.12 How much **cash income** does your household earn in **1 month** on average in Birr?

1 month = 30 days; include the income of **all family members who are working in the household's house**

Display This Question:
If Q3.2 Is Greater Than 1

Q3.13 Does the household also earn in-kind income?

In-kind income are **NON-cash payments** for services the household renders to others.

These non-cash payments can be food, right to use the land of someone else to farm etc.

- ☐ Yes
- ☐ No

4. CHOICE EXPERIMENT - CONSUMER SIDE INTRODUCTION

Display This Question:

If Q1.12 = Yes

And Q1.13 = No

Q4.1 Image that you move to another area than the one you are living now (for example another sub-city within Mekelle). In this new area, you would like to buy 1 litre of fresh, liquid milk. We will present you different alternative and unknown sellers of milk from whom you can buy your 1 litre of milk. Select the seller that you prefer most using the described characteristics for each seller. There are no right or wrong answers. You may opt to choose none of the sellers described.

Display This Question:

If Q1.12 = Yes

And Q1.13 = No

Q4.2 The sellers we present you can be an individual urban **milk producer** or a **milk shop** who got the milk from a farmer.

These sellers will ask you different prices for 1 litre of milk **and** the **distance** you have to **walk by foot (one-way)** from your house to the sellers will differ.

5. Choice experiment - producer side Introduction

Display This Question:

If Q1.13 = Yes

Or Q1.12 = No never, milk and dairy products are all produced within the household or received from others

Q5.1 Image that **you move to another area** than the one you are living now (for example another sub-city within Mekelle). In this new area, you would like to **sell 1 litre of fresh, liquid milk**. In the following you will see alternative and unknown buyers available to you for selling your fresh milk to. Select the buyer that you prefer most using the described characteristics for each buyer. There are no right or wrong answers. You may opt to choose none of the buyers described.

Display This Question:

If Q1.13 = Yes

Or Q1.12 = No never, milk and dairy products are all produced within the household or received from others

Q5.2 These buyers we present you can be either a **direct consumer** who picks up the milk at your farm, a **trader** who picks up the milk at your farm and who will sell it to somebody else, or a **milk shop** where you should deliver the milk to the shop itself. These buyers will pay different prices for your 1 litre of milk and this payment can be either **direct** (you get your money the moment you give them the milk) which will be represented by this symbol



or **delayed** (you get your money later, not at the moment you give them the milk) which will be represented by this symbol



6. CHOICE EXPERIMENT

7. DIRECT DEBRIEFING - CONSUMER SIDE

Display This Question:

If Q1.12 = Yes

And Q1.13 = No

Q7.1 Could you formulate in your own words what this study is about?
Why do we ask you these questions?

Display This Question:

If Q1.12 = Yes

And Q1.13 = No

Q15.2 Do you know the name(s) of your milk supplier(s) in the real world?

☐ Yes

☐ No

Display This Question:

If Q15.2 = Yes

Q15.3 What is/are the name(s) of your milk supplier(s)?

Display This Question:

If Q1.12 = Yes

And Q1.13 = No

Q15.7

Please rank the following characteristics according to their importance when choosing a fresh milk supplier;

1 represents the most important characteristic

2= 2nd most important characteristic

3= 3th most important characteristic

4= 4th important characteristic

5= least most important characteristic

	1	2	3	4	5
Type of supplier (farmer, milk shop)	☐	☐	☐	☐	☐
Gender of supplier (male, female)	☐	☐	☐	☐	☐
Religious background of supplier	☐	☐	☐	☐	☐
Distance to supplier	☐	☐	☐	☐	☐
Milk price	☐	☐	☐	☐	☐

8. DIRECT DEBRIEFING - PRODUCER SIDE

Display This Question:

If Q1.13 = Yes

Or Q1.12 = No never, milk and dairy products are all produced within the household or received from others

Q8.1 Could you formulate in your own words what this study is about?
Why do we ask you these questions?

Display This Question:

If Q1.13 = Yes

Or Q1.12 = No never, milk and dairy products are all produced within the household or received from others

Q8.2 Do you know the name(s) of your milk buyer(s) in the real world?

- ☐ Yes
☐ No

Display This Question:

If Q16.2 = Yes

Q8.3 What is/are the name(s) of your milk buyer(s)?

Display This Question:

If Q1.13 = Yes

Or Q1.12 = No never, milk and dairy products are all produced within the household or received from others

Q16.4

Please rank the following characteristics according to their importance when choosing a fresh milk buyer;

1 represents the most important characteristic

2= 2nd most important characteristic

3= 3th most important characteristic

4= 4th most important characteristic

5= least most important characteristic

	1	2	3	4	5
Type of client (direct consumer, trader, milk shop)	☐	☐	☐	☐	☐
Gender of client (male, female)	☐	☐	☐	☐	☐
Religious background of client	☐	☐	☐	☐	☐
Type of payment (immediate or delayed)	☐	☐	☐	☐	☐
Milk price	☐	☐	☐	☐	☐

9. TRUST

Q9.1 Generally speaking, would you say that most people can be trusted or that you need to be very careful in dealing with people?

- ☐ Most people can be trusted
- ☐ You need to be very careful
- ☐ I don't know

Q9.2 I'd like to ask you how much you trust people from various groups. Could you tell me for each of the following groups of people whether you trust people from this group completely, somewhat, not very much or not at all?

	Trust completely	Trust somewhat	Do not trust very much	Do not trust at all	I don't know	It depends
Your family	☐	☐	☐	☐	☐	☐
Your neighborhood	☐	☐	☐	☐	☐	☐
People you know personally	☐	☐	☐	☐	☐	☐
People you meet for the first time	☐	☐	☐	☐	☐	☐
People of another religion	☐	☐	☐	☐	☐	☐
People of another nationality	☐	☐	☐	☐	☐	☐

10. RELIGION QUESTIONS

Q10.1 To which religious group do consider yourself to belong too?

▼ Orthodox ... Other

Display This Question:

If To which religious group do consider yourself to belong too? = Orthodox

Q10.2 Do you participate in the Assumption fast?

- ☐ Yes
- ☐ No

11. RELIGIOSITY QUESTIONS

Q11.1 While I am a Muslim/Protestant/Catholic/Orthodox, I do not let my faith influence my daily life.

- ☐ Strongly agree
- ☐ Agree
- ☐ Not certain
- ☐ Disagree
- ☐ Strongly disagree

Q11.2 Occasionally I have compromised my Muslim/Protestant/Catholic/Orthodox beliefs to fit in better with other people.

- ☐ Strongly agree
- ☐ Agree
- ☐ Not certain
- ☐ Disagree
- ☐ Strongly disagree

Q11.3 One reason for me going to mosque/church is to connect with others.

- ☐ Strongly agree
- ☐ Agree
- ☐ Not certain
- ☐ Disagree
- ☐ Strongly disagree

Q11.4 A key reason to go to mosque/church is that it is socially enjoyable.

- ☐ Strongly agree
- ☐ Agree
- ☐ Not certain
- ☐ Disagree
- ☐ Strongly disagree

Q11.5 I go to mosque/church because it helps me to feel part of a community.

- ☐ Strongly agree
- ☐ Agree
- ☐ Not certain
- ☐ Disagree
- ☐ Strongly disagree

Q11.6 One reason for me praying is that it helps me to gain relief and protection.

- ☐ Strongly agree
- ☐ Agree
- ☐ Not certain
- ☐ Disagree
- ☐ Strongly disagree

Q11.7 What prayer offers me most is comfort when bad things happen to me.

- ☐ Strongly agree
- ☐ Agree
- ☐ Not certain
- ☐ Disagree
- ☐ Strongly disagree

Q11.8 I pray mainly because it makes me feel better.

- ☐ Strongly agree
- ☐ Agree
- ☐ Not certain
- ☐ Disagree
- ☐ Strongly disagree

Q11.9 While I believe in the Muslim/Protestant/Catholic/Orthodox faith, I feel there are more important things in my life.

- ☐ Strongly agree
- ☐ Agree
- ☐ Not certain
- ☐ Disagree
- ☐ Strongly disagree

Q11.10 My Muslim/Protestant/Catholic/Orthodox faith shapes how I live my daily life.

- ☐ Strongly agree
- ☐ Agree
- ☐ Not certain
- ☐ Disagree
- ☐ Strongly disagree

Q11.11 I try hard to carry my Muslim/Protestant/Catholic/Orthodox belief over into all other areas of my life.

- ☐ Strongly agree
- ☐ Agree
- ☐ Not certain
- ☐ Disagree
- ☐ Strongly disagree

Q11.12 My Muslim/Protestant/Catholic/Orthodox faith really shapes the way I treat people.

- ☐ Strongly agree
- ☐ Agree
- ☐ Not certain
- ☐ Disagree
- ☐ Strongly disagree

Q11.13 I allow almost nothing to prevent me from going to mosque/church on Fridays.

- ☐ Strongly agree
- ☐ Agree
- ☐ Not certain
- ☐ Disagree
- ☐ Strongly disagree

Q11.14 I go to mosque/church because it helps me feel close to Allah/God.

- ☐ Strongly agree
- ☐ Agree
- ☐ Not certain
- ☐ Disagree
- ☐ Strongly disagree

Q11.15 The mosque/church is most important to me as a place to be part of Allah's/God's family.

- ☐ Strongly agree
- ☐ Agree
- ☐ Not certain
- ☐ Disagree
- ☐ Strongly disagree

Q11.16 I pray at home because it helps me be aware of Allah's/God's presence.

- ☐ Strongly agree
- ☐ Agree
- ☐ Not certain
- ☐ Disagree
- ☐ Strongly disagree

Q11.17 I often read books about my religion.

- ☐ Strongly agree
- ☐ Agree
- ☐ Not certain
- ☐ Disagree
- ☐ Strongly disagree

Q11.18 I pray mainly because it deepens my relationship with Allah/God.

- ☐ Strongly agree
- ☐ Agree
- ☐ Not certain
- ☐ Disagree
- ☐ Strongly disagree

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Curriculum vitae

About the author

Eline D'Haene (°Ghent, 22th of February 1992) graduated *summa cum laude* as Master of Science in Bioscience Engineering: Agriculture in 2015. For her master's thesis, she went to the north-east of the Democratic Republic of Congo and examined pathways to contribute to improved smallholder crop productivity, in close collaboration with VLIR-UOS. After her studies, she started as a PhD candidate with BOF grant in October 2015 at the department of Agricultural Economics of Ghent University. In October 2016, she became academic assistant at the department. During her PhD, she intensively collaborated with several colleagues both within and outside the department, at Ghent University but also at KU Leuven. In those five years, she went several times to Ethiopia for field work in the milk sector, presented her work at international conferences and published in peer-reviewed journals. As an assistant, she co-lectured several courses in various national and international master programmes. She supervised students for bachelor projects and master theses that cover a wide range of topics – from more nutrition-related topics towards (socio-)economic focuses.

Education

2015 - present	PhD candidate in the research group Rural Development Ghent University
2015 - 2013	Master of Science in Bioscience Engineering: Agriculture Ghent University
2013 - 2010	Bachelor of Science in Bioscience Engineering Ghent University

Professional experience

2015 - present	Academic assistant at the department of Agricultural Economics Ghent University

Assisting in the following Master programmes:

- International Master of Science in Rural Development (IMRD)
- Master of Science in Nutrition and Rural Development
- Master of Bioscience Engineering: Agriculture
- Master of Science in Complementary Studies in Economics
- Master of Science in Economics
- Master of Science in Teaching in Social Sciences (Political Science)
- Master of Science in Conflict and Development Studies

Assisting in the following courses:

- Development Economics
- Rural Development and Agriculture: A global South perspective
- Rural Project Management
- Seminars and Scientific Communications on Rural Development
- Biologische landbouw (Dutch)
- Agrarische bedrijfseconomie (Dutch)
- The module Economics in the BE Prepared course

Jury member, tutor, and co-promotor of various Master dissertations

Specialist trainings

Academic year 2015-2016	Institutional economics (Ghent University)
	Behavioural economics (Ghent University)
	Spring school of the Institutional and Organizational Economics Academy
	Training in guidance of writing assignments (Ghent University)
	Basic training for academic assistants (Ghent University)
	Feedback training (Ghent University)
	Advanced Academic English: Conference Skills (Ghent University)
	The Leadership Foundation Course (Dan Steer)
Academic year 2016-2017	Course on EU-policies regarding agriculture, food and nature (Wageningen University)
	Summer school Let's talk Science (Ghent University, University of Antwerp, University of Hasselt, University of Leuven, and Vrije Universiteit Brussel)
	Workshop on Stated preferences track (Humboldt University)
	Choice experiments in Agricultural and Food Economics (KU Leuven)
Academic year 2017-2018	Personal Effectiveness (Tom Jacobs, T.O.M. bvba)
	UCSIA Summer School "Religion, Culture and Society: 'Between Market, State and Religion: Economic Realities, Social Justice and Faith Traditions"
	Evaluating: The basics (Ghent University)
	Feedback: A strong educational tool (Ghent University)
	Workshop Choice Experiments (Antwerp University)

Academic year 2018-2019 Grow your future career (Robin Lefebvre, Grow2Excel)
Communication skills - Basic (True colours)
Negotiation skills (True colours)
Conflict handling (True colours)
Feedback for large groups (Ghent University)
The secrets of successful groupwork (Ghent University)
Community Service Learning (Ghent University)
Motivational teaching (Ghent University)

Publications

Peer reviewed scientific journal papers

D'Haene, E., Desiere, S., D'Haese, M., Verbeke, W., and Schoors, K. (2019). Religion, food choices, and demand seasonality: Evidence from the Ethiopian milk market. *Foods*, 8 (5): 167. DOI: 10.3390/foods8050167

D'Haene, E., and D'Haese, M. (2019). Milk in the city: Profiles and development paths for urban dairy holders in Ethiopia. *Development Southern Africa*. DOI: 10.1080/0376835X.2019.1689099

Amulen, D.R., D'Haese, M., D'Haene, E., Okwee Acai, J., Agea, J.G., Smagghe, G., and Cross, P. (2019) Estimating the potential of beekeeping to alleviate household poverty in rural Uganda. *PLoS ONE* 14(3): e0214113. DOI: 10.1371/journal.pone.0214113

Under review

D'Haene, E., Tur Cardona, J., Speelman, S., Schoors, K., and D'Haese M. Unravelling preferences for religious ties in food transactions: A buyer perspective. *Agricultural Economics*

Policy report

D'Haene, E., Vandeveld, S., and Minten, B. (2020) Fasting, food, and farming Evidence from Ethiopian producers on the link of food taboos with dairy development. Ethiopia Strategy Support Program Working Paper No. 141, International Food Policy Research Institution and Ethiopian Development Research Institute.

Oral presentations in conferences and workshops

1. *Milk in the city: Profiles and development paths for urban dairy holders in Ethiopia* presented at the Spring school of the Institutional and Organizational Economics Academy, 2016, Corsica
2. *Religion, food choices, and demand seasonality: Evidence from the Ethiopian milk market* presented at on the PhD workshop 'Challenges for young agro-food and natural resource economists facing the future' organized by the European Association of Agricultural Economics, 2017, Spain
3. *Religion, food choices, and demand seasonality: Evidence from the Ethiopian milk market* presented at the UCSIA Summer School 'Religion, Culture and Society: Between Market, State and Religion: Economic Realities, Social Justice and Faith Traditions', Belgium, 2017
4. *Religion, food choices, and demand seasonality: Evidence from the Ethiopian milk market* presented at the International Conference of Agricultural Economists, 2018, Canada
5. *Unravelling preferences for religious ties in milk transactions: A buyer perspective* presented at the International Conference of Agricultural Economists, 2018, Canada, as panel member at organized session 'Coordination of supply chains: How can insights from choice experiments contribute?'
6. *Milk in the city: Profiles and development paths for urban dairy holders in Ethiopia* presented at Tropentag, Belgium, 2018 and chair of the respective session 'Global food security and food safety: The role of universities'
7. Several paper presentations at the yearly PhD symposium organized by the Belgian Association of Agricultural Economists

