THE RELATIONSHIPS BETWEEN LIVESTOCK AND HUMAN WEALTH, HEALTH, AND WELLBEING IN A RURAL MAASAI COMMUNITY OF SOUTH-WESTERN KENYA

by

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Abstract

Livestock are critical to the livelihood of up to two billion global poor and thus represent an ideal focus for poverty amelioration. For traditional keepers, livestock are: culturally significant, nutritionally important, and serve as "daily currency" and household "savings". However, they may also increase infectious disease risk, especially via zoonoses which can reduce both human and livestock health and quality of life. Although many studies exist on livestock-dependent communities, including the Maasai and other pastoralists, significant knowledge gaps persist regarding the relationships between traditional livestock-keeping and human wellbeing.

This dissertation investigated associations between pastoral livestock and owner health through a series of cross-sectional and longitudinal studies conducted in Olkoroi, a rural Maasai community. The objectives were to: 1) review the literature on connections between livestock health and productivity, and human wealth, health and wellbeing; 2) describe Olkoroi sociodemography and capital; 3) assess local human and livestock disease priorities and livelihood challenges; 4) conduct longitudinal studies of livestock growth, livestock and human infectious disease; 5) measure adult psychological wellbeing; and 6) use the collected data to build predictive models of human wellbeing, herd size, livestock growth, livestock and human infectious disease frequency.

I found livestock were the primary livelihood and predicted psychological wellbeing, but 40% of households, primarily female-headed, had insufficient animals to support themselves. Men and women identified similar factors affecting wellbeing but differed in proportional attribution: women uniquely spoke of restrictions on autonomy. Community disease prioritizations were similar to national priorities, however, disease management was inconsistent and causal understanding was low. Households self-rated husbandry practices highly, but felt financial constraints prevented adoption of best practice. Household variables were associated with herd size, but climate was the best predictor of livestock growth, and livestock and human infectious disease: livestock disease prevalence did not predict human disease. My results suggest livestock research must prioritize gender and local context to better understand livestock-human health relationships. Claims about the contribution of livestock to human disease burdens must also be clarified through more consistent research

frameworks which allow inter-study comparisons, and more longitudinal studies to better identify causal relationships between exposures and disease incidence.

Lay Summary

How livestock affect human wellbeing in rural poor communities is not fully understood. My research explored human-livestock relationships in Olkoroi, a Kenyan Maasai community. Livestock remains culturally important, and residents are confident about their herding practices. Herd size reliably indicates wealth and predicts herder happiness. Single parents are almost exclusively women, typically lack livestock, and consequently struggle to support their children. Some women feel restricted by tradition, and a lack of government infrastructure increases health risks and limits livelihood diversification. Community members believe that livestock does not contribute significantly to human disease: my research supports their belief, as I find that human and livestock disease are both primarily associated with climate. I recommend that keeper perspectives should be prioritized in future research and development initiatives in rural poor settings, because keepers have the most knowledge about their livelihoods and how they are affected by the ecosystems in which they live.

Preface

This dissertation is original, unpublished, independent work by the researcher and author, Catherine Glass. Data presented and analysed in chapters 3-7 were covered by UBC Ethics Certificate H07-02752 and the Kenya Medical Research Institute Non-Scientific Steering Committee Protocol Number 164.

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Abbreviations

ACCC – Association of Canadian Community Colleges (now CICan - Colleges and Institutes Canada)

AMREF – African Medical and Research Foundation

ASAL – arid and semi-arid lands

ASF – animal source foods

AU – African Union

BP – blood pressure

Bpm – beats per minute

CE – cystic echinococcosis

CMF – Christian Missionary Fellowship

DEO – District Education Office

DFID – [U.K.] Department for International Development

DHS – Demographic Health Survey

DVO – District Veterinary Office

FHH – female headed households

GCC – global climate change

GBD – Global Burden of Disease

GDP – gross domestic product

GI – gastrointestinal

Hb – hemoglobin

HCW – healthcare workers

HIV – human immunodeficiency virus

HoH – head of household

IGAD – International Authority on Development

ILRI – International Livestock Research Institute

IMF – International Monetary Fund

KSh – Kenyan shillings

LID – Livestock in Poverty-Focused Development

LMIC – low and middle income countries

MDG – Millennium Development Goals

MeSH – Medical Subject Headings

MHH – male headed household

mmHG – millimetres of mercury

MPI – Multidimensional Poverty Index

MUAC – Mean upper arm circumference

NGO – non-governmental organisation

OD – open defecation

OIE – Office International des Epizooties (OIE aka World Organisation for Animal Health)

OPHI – Oxford Poverty and Human Development Initiative

PRSP – Poverty Reduction Strategy Paper

PVS – Performance of Veterinary Service

SAP – Structural Adjustment Program

SSA – Sub-Saharan Africa

STIs – sexually transmitted infections

SWLS – Satisfaction with Life Scale

TBD – tick-borne disease

TFR – Total fertility rate

TLU – tropical livestock unit

UNDP – United Nations Development Programme

UTIs – urinary tract infections

WASH – water, sanitation and hygiene

WB – World Bank

WHO – World Health Organisation

WVS – World Values Survey

Glossary: Maasai/Swahili/Kenyan Vernacular

Agrivet – non-veterinary vendors of agricultural pharmaceuticals with widely varying training (in rural areas, usually informal if any)

Ashe oleng - thank you very much (Maa)

Enkashumpai – Caucasian female (Maa)

Kati-kati – in the middle, between (Swahili)

Maa – the Maasai language

Mayiolo – I don't know (Maa)

Moran – warrior (Maa)

Ole – approximately equivalent to "Mr." (Maa)

Shamba – farm or garden plot (Swahili)

Sidai- good/excellent/beautiful (Maa)

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It has been a very long road to completion, and the list of people and institutions to whom I owe thanks is lengthy. In the space allotted, I can only tip my metaphorical hat to both those who have provided key support at specific times, and those who never stopped keeping the faith that I would one day finish (or if they did, did a great job of hiding it)!

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Dedication

This dissertation is dedicated to my children, Sarah Glass, Brynmor Crookall, Cadan Glass and Daniel Crookall, who changed my life irrevocably for the better.

Also, the people of Olkoroi for their welcome, kindness, patience and extensive collaboration in the research reported within, most especially to Ole Alfred Leroka Koshal, and to Noosokon Sironik, a young woman cruelly taken from life too soon.

Chapter 1: Introduction, Background, Research Justification, Goals and Objectives

1.1 Introduction

Numerous livestock-based interventions intended to improve national and to a lesser degree, household wealth, have been implemented in the developing world since the turn of the 19th century. Initiatives have been driven by varied motives: supplying colonial and post-colonial metropoles;[1] stimulation of economic growth and poverty alleviation via agriculture (a significant contributor to the economy of many developing countries);[2, 3] and ameliorating imbalances in domestic supply versus demand for livestock products in many poor nations.[4, 5] Livestock are an ideal focus for poverty reduction efforts because of their dual role in national and family economies, relevance in the livelihoods of a large proportion of the global poor,[6] and potential for health promotion, both through the nutritional value of animal-source foods (ASF)[7] and the association between economic security and health.[8-10]

Livestock-based interventions, past and present, have primarily focused on increasing revenues rather than health improvements of animal keepers,[a] with the assumption (if health was even considered) that greater wealth would directly translate into uniform improvements in health and socioeconomic status (SES).[9] This can be the case, but increasing revenue from traditional livestock systems such as pastoralism, upon which the poor typically depend, has rarely been a simple endeavor: "Despite…bright spots demonstrating the possibility of alternative pathways, overall, mainstream pastoral development is a litany of failure, involving substantial sums of wasted resources".[12] To expect that increased revenue alone will lead to improved SES, much less, a commensurate increase in wellbeing and health for each member of all participating households is not a validated assumption.[9]

To ensure that benefits from livestock development are at least potentially available to everyone in a poor community requires extensive initial consultation with representatives from all sectors of the community. Marginalized members may need support to access the

[a] There are some exceptions, for example, targeted efforts to reduce the prevalence of parasites such as T. solium, however, these efforts are also often hampered by infrastructural weakness in the poorest nations.11. Gabriël S, Dorny P, Mwape K, Trevisan C, Braae UC, Magnussen P, et al. Control of Taenia solium taeniasis/cysticercosis: the best way forward for sub-Saharan Africa? Acta tropica. 2017;165:252-60.

discussion, and external actors must have a thorough understanding of local capital from the individual, to the household, community and ecosystem.[13-15] Historically, such necessary preliminary research has rarely happened and the general consensus of the research and development community is that most livestock-mediated poverty interventions have been unsuccessful.[14, 16-23] This has primarily resulted from inadequate consultation with those affected. But it is also the consequence of a lack of genuine focus on the poor, in turn leading to a failure to understand the varied drivers, perpetuators, and outcomes of poverty.[14, 16, 22, 24] There has also been a consistent inability to learn from failures.[25] Moreover there is a scarcity of research on livestock health and welfare, ***and*** the wealth and health of poor livestock keepers simultaneously.[26-28] Literature exists on each subject separately, as well as theoretical discussion of how they relate. But, without studies which collect information on both concurrently, it is difficult to fully understand the complexities,[26] or test hypotheses about animal-human health and wealth relationships. Perry and Grace summed up this lack of clarity, noting: "…livestock probably matter to poverty reduction, but we are not sure exactly how or how much".[29] A further complication is that livelihood, livestock and human demographic data, and health metrics from the developing world are often insufficient in quantity and quality.[30] Evidence is not always current,[31] is primarily derived from cross-sectional studies,[32, 33] and is frequently non-generalizable because of difficulties in collecting representative data from rural areas (where most poor livestock owners live[8]) and marginalized populations,[8, 15, 26, 34-42] especially in insecure regions.[43] Lastly, research in rural communities, for either preliminary investigations or intervention evaluation, is rarely conducted long enough to draw fully informed conclusions on the relevant descriptive epidemiology, possible outcomes and/or effectiveness of interventions.[44-46]

In discussion of the potential, necessary priorities, and roadblocks in pro-poor development, insufficient agricultural research funding in many countries has been highlighted [29] particularly with regards to livestock and initiatives relevant to smallholders. National funding deficits have been exacerbated by a global decline in funding for both basic research[47] and development initiatives focused on agricultural animals.[48-50] Perry and Sones further suggested much of the existing research was unlikely to help the poorest citizens of the poorest nations because: "…sectors of the affluent world are still basing their science

contributions to poverty reduction on self-interest…At the moment, only the crumbs go to the poor".[51] Adding to these challenges are barriers such as lack of resources and infrastructure,[52] corruption,[53, 54] social feasibility and political will at all levels including the individual[29] in target nations.[19] At the same time, no one prescription is likely to fit all circumstances, even within single communities.[19, 45, 55, 56] The associations between livestock and the wealth, health and psychological wellbeing of their keepers are diverse and complex[57] although common underlying relationships frequently exist.

There is substantial evidence to support the conclusion that livestock can positively affect the SES and health of their owners. With sufficient resources and sustained market demand, [6, 19, 52, 58, 59] livestock provide income for maintenance and improvement of household social, material and human capital. ASF are an accessible supply of high value nutrients, and in many traditional societies, livestock play important cultural roles which contribute to psychological wellbeing. On the negative side, livestock may cause injury to their keepers and increase risk of zoonotic infection. Livestock-human relationships, and the potential of livestock to ameliorate poverty and improve health, are the focus of a substantial quantity of academic and development literature. Yet, for a variety of reasons, there is still insufficient evidence to support many of the widely mooted claims about these relationships,[27, 60] and guide more effective development efforts. This is especially the case for pastoralism, an ancient practice still followed by millions globally, and now recognised as one of the most environmentally sustainable, traditional, livestock-dependent livelihoods.[61]

1.2 Justification of Research Focus

Globally, the highest proportion of poor livestock keepers live in Asia and Africa.[14] In Africa, pastoralists make up a major fraction of livestock-keepers, and are important contributors to agricultural productivity.[62] Nonetheless, pastoralists have not been supported or incorporated into national decision making in a manner commensurate with their contributions to the livestock economy.[17, 63] In 2013, the African Union (AU) recognised and affirmed the importance of pastoralism to African economies but simultaneously acknowledged "…that pastoralists are among the most politically and economically marginalized communities".[64] There also remains a paucity of accurate sociodemographic

information on pastoral households,[61, 65] and stereotypes about pastoral motivations and behaviour persist.[66-68] Little information is available on evolving structures of pastoral households[69] and possible increases in the number of female-headed households (FHH), although some information has been reported on shifting cultural values, and changing roles for pastoral women.[70, 71] FHH may already make up a high proportion of community households due to a combination of traditional marriage practices and social changes. While it has been suggested that changing pastoral practice is increasing autonomy for some women, FHH may be among the most vulnerable of a marginalized population.[71]

Historic evidence suggests livestock research and development agendas in general, but also specifically as regards pastoralists, have not been effective because of frequent failure to identify or focus on:

- production systems used by pastoralists[72, 73]
- the self-identified needs/priorities of target populations[16, 17]
- the most vulnerable within poor populations[17, 66]
- women's role in livestock keeping[74], and the livestock (typically small ruminants such as sheep and goats) which are most accessible to women and the poor[75-77]

In addition, measurement tools frequently fail to take into consideration intra-household differences in autonomy, information access, and control over family assets, especially livestock.[71, 74] Despite much discussion of the importance of livestock in the wellbeing of the poor, most human-livestock health relationships discussed in the literature are theoretical[60] because few studies have collected data on livestock and human health simultaneously.

In the last three decades, there has been a strong publication emphasis on the role of zoonoses as a barrier to movement of livestock keepers, especially pastoralists, out of poverty,[9, 14, 78-82] although insufficient evidence has been collected to generalize this assertion. While some zoonotic illnesses can have substantial impact on household wellbeing, distribution and relative importance vary widely.[83] Some of the most recent studies and reviews of zoonoses appear to contradict the widespread and repeated claims about their importance and prevalence in humans and livestock, especially as regards brucellosis, one of the most studied of the zoonoses in the Global South.[83-91]

Livestock-focused development initiatives make enormous intuitive sense for the multiplicative benefits, including the health of livestock keepers, their success could bring. Not only could livestock-keeping populations benefit, but also consumers and related industries, and ultimately national economies through the chain of livestock production, and export markets. Changing the history of failure in livestock development initiatives, however, requires a direct focus on poor livestock keepers, accurate knowledge of their circumstances and needs, and most importantly a meaningful participatory process that allows the populations of interest to articulate their needs, priorities, and goals for themselves.

1.3 Background (emphasis on Africa, Kenya and the Maasai)

1.3.1 Modern Pastoralism

Pastoralism is practiced around the world from Asia, Europe, and the circumpolar North, to North, Central and South America, India and Africa[73], but approximately half of all pastoralists are found in Africa.[92] Although pastoralism is conceptually well known, and some practitioners, like the Maasai are "famous" (in part for their warrior tradition, but in greater part because of their "cattle complex"[93] a term coined in the 1920s by Melville Herskovits, which encompassed not just a livestock dependent livelihood, but a tradition in which livestock were central to all significant aspects of life), there is a deficiency of quality data on pastoral numbers and livestock holdings.[94] In Kenya, pastoralists in Northern Kenya were excluded from the National Demographic and Health Surveys (DHS) until 2003, and similar exclusions from national data collections have been common in other countries.[95]

Pastoral practice is not uniform, but exhibits common characteristics: a livelihood primarily dependent on livestock; occupation of arid and semi-arid lands (ASAL) unsuited to plant-based agriculture because of erratic water supply;[96] cyclical movements driven by water and/or pasture availability and sometimes disease distribution; communally owned land; a legal system based on customary law;[97] and a livestock-centred culture that imbues much of daily and ceremonial life.[98] Low productivity of ASAL has been traditionally offset by communal ownership of extensive territory, which supports substantial herds. The combination of large land holdings, mobility, and relatively low inputs of labour, materials and money, make pastoralists, contrary to much historical representation, extremely efficient

producers and stewards of fragile ecosystems which may not support other livelihoods.[29, 61, 99] Politically, the meaning of pastoralism has varied dependent on the defining body. In Kenya, for example, official pastoral designation is lost with a move to semi or fully urban environments.[95] However, there is a long, documented history of pastoralists passing in and out of "classic" pastoralism, including extended time spent in urban centres, without relinquishing their identity.[98] Pastoralism requires adaptability to patchy and unpredictable events, resources, and climates.[17, 68] This necessary flexibility is another defining feature of pastoral life.[94, 96] Pastoralists are also frequently marginalized.[68] They may literally live on the "edges" of their countries, inhabiting or relegated to unwanted or inhospitable lands,[17] but metaphorically they frequently inhabit national peripheries, disenfranchised, misrepresented, underrepresented and underserved by governments.[100, 101] Although marginalization is usually viewed as a detriment, at least one pastoral researcher has suggested marginalization has benefits, at least to those with the most power within pastoral communities.[102]

In Africa and academia, pundits have argued about the viability of traditional pastoralism since first colonization.[68] The modern consensus is that pastoralism is resilient, but pastoralists globally face similar, ongoing challenges. Governments have long endeavored to settle them, not always for pastoralist benefit.[73, 103-106] In a 2008 debate about future pastoral viability, four options were identified: maintaining exclusively traditional practice, supporting traditional practice via diversification, adoption of high intensity production (rarely feasible due to cost and lack of resources in ASAL), or settling and leaving pastoralism for other occupations.[13] The last option, without access to alternate livelihoods which may require capital, training and higher education,[107, 108] has a high likelihood of causing (further) impoverishment and diminished health.[109, 110] Settling can however, create new opportunities and allow women in particular to explore avenues that might otherwise be unavailable in a traditional livelihood system.[102, 111, 112]

Huge customary land areas in Africa have been lost to colonial and post-colonial governments. "Land grabs" continue, via creation of hunting concessions, "development" projects, conversion of pasture into cropland, and acquisition of "waste or underutilized territory" by foreign owners.[66, 94, 113, 114] Government mandated subdivision and privatization of communal land, in part driven by unsubstantiated theories about agricultural

productivity,[25] have occurred for decades in East Africa and other pastoral regions. Privatization results in both increased and decreased security,[25] and increases settlement pressure (in part due to reduced mobility).[115] Security theoretically increases because legally documented land title can be used as collateral in commercial transactions and may prevent land manipulation/theft by outsiders. Some Kenyan work, however, suggested that holding land title neither increased productivity, nor facilitated access to credit, particularly for the poor and women.[25] Decreased security further occurs when individual ownership, in combination with sales, increased settling, and population expansion lead to territorial fragmentation. Fragmentation precludes rights of movement required for extensive pastoralism[70, 116, 117] and may also increase susceptibility to drought and global climate change (GCC).[115] Kenyan pastoralists with newly held private land have also been repeatedly manipulated by those with more commercial experience and/or corrupt intent.[118-120] Misunderstanding of the requirements of individual landownership has also led to land loss when owners have not collected their deeds, or when head of households (HoH) have died and the property is not, or cannot be (often for women[121]) re-registered.[25, 122]

Customary law still holds strong in many pastoral communities but tends to be eroded by national law. In rural Maasailand, increased contact with the outside world via higher rates of formal education and technological advances, has led to more awareness of legal rights,[123] especially for women and children. As with settlement, national laws may provide increased protection and avenues by which the less powerful in Maasai hierarchy can seek "justice". However, they also weaken cohesiveness and the strong fabric of Maasai custom that have historically preserved tribal identity against outside forces.[123]

Politicians, development agencies, scientists, and pastoralists themselves have asserted the need for diversification and there has been substantial documentation of this process.[108] Diversification is frequently posed as a survival necessity caused by reduced capacity to follow historic livelihood due to: changing agricultural practices;[124] population growth;[125] civil and national conflicts;[66, 125] corruption;[108, 126-129] loss or enclosure of land;[120, 125, 130] impoverishment due to livestock loss, drought and livestock disease;[131, 132] and/or breakdown of the cultural safety net.[108, 112, 133-135] The safety net still constitutes approximately 10% of pastoral holdings,[136] most commonly in the form of animal gifts or

loans to those who have suffered livestock losses. It is, however, believed by both academics and pastoralists to be significantly diminished[134] due to increased poverty,[107, 115] loss of cultural tradition,[137, 138] and adoption of modern economic practices.[139]

Many diversification interventions and strategies have been promoted and described,[68] but historic accounts indicate the Maasai and other pastoralists have always diversified by their own initiative as necessary. Non-pastoral revenue generation activities include: remittances; salaried work in game reserves, tourist camps, service industries, and civil service positions; small business ranging from petty trade to more formal activity such as construction and transportation; investment in new breeds and livestock technology such as artificial insemination; crop-based agriculture; mining; and even land and resource speculation.[108] Rarely mentioned is the participation of both Maasai women (from colonial times)[137, 140, 141] and men (recently catering to female tourists in locations such as Mombasa and Zanzibar[142]) in the sex trade. Another revenue generator infrequently referenced is participation in Western funded missionary work which may be one of the few educational avenues and/or opportunities for salaried employment in remote African communities.

Although diversification trends are often explained by the "decline" or "unsustainable" nature of pastoralism, diversification is often pursued to support traditional practice.[124] Multiple authors have documented pastoralists across East Africa directing diversification revenue back to a core family unit to support herd recovery, maintenance and/or expansion.[94, 112, 143] Some, forced out of pastoralism by livestock loss, diversify for survival, but hope to return to pastoralism.[13, 107, 108, 144-146] Settlement, also, does not preclude continuation of mobile pastoralism within an extended family, and may facilitate diversification. Research in Marsabit, Kenya, found settled Kargi households had more mobile livestock than nomadic families in North Horr. Livestock rather than family mobility was hypothesized to explained higher Kargi livestock productivity.[107]

Despite government and development sector enthusiasm for greater diversification as a solution to livelihood difficulties, Kenyan evidence suggests both diversification from[13, 147] and maintenance of primarily pastoral activity can predict better health, financial stability and wealth,[108] even within the same community.[144] Conversely, diversification may be associated with economic decline, especially when driven by significant or complete

livestock loss.[13, 66, 107, 148] While diversification appears to be a pastoral tradition, there is some debate about current diversification patterns. Some research suggests that the poorest and wealthiest are most likely to diversify,[108, 112] the former because of need and the latter to protect assets and increase resilience. Others have suggested that all strata are diversifying due to cultural, economic, and civil influences.[124, 125, 130, 143] There is further question as to whether current trends are similar to past coping mechanisms or represent a permanent livelihood shift with potential long-term consequences for pastoral identity.[124, 143]

1.3.2 Health and Pastoralism

Hypotheses about the effects of pastoralism on human health have primarily been tested via studies on health relative to size of livestock holdings and comparisons of zoonoses prevalence in livestock and their keepers. Studies include comparisons between different types of pastoralists, between pastoral and settled tribes, and between settled (with or without livestock) and mobile pastoralists of the same tribe.[144, 149-151] A variety of study designs and data sources have been used although most research is cross-sectional. A longitudinal study on livestock-human health associations is ongoing in the non-pastoral Luo in Western Kenya.[27] Overall, conclusions are inconsistent and may not be generalizable. Studies which use DHS, for example, are limited by the breadth and detail of data collected, and a focus on women and children.[152] In addition, pastoralist health status may be unrelated to livelihood, data collection can be difficult and/or biased due to social factors and sampling challenges,[152, 153] and the body of literature is variable in focus, study design, and is relatively small.[26] Infrastructure limitations in many developing countries result in unreliable morbidity and mortality data, especially for rural populations,[154] and data collection often omits mobile pastoralists[65, 139] and insecure regions.[155] For example, an Ethiopian review of maternal mortality concluded available data were inadequate to make valid conclusions about causation or calculate accurate national mortality rates, and there was no data at all on pastoralists.[156] Researchers documenting morbidity and nutrition in Chadian pastoralists were unable to follow-up on individuals from season to season due to mobility effects.[152] Research bias also interferes with data validity because few researchers are willing to live in remote locations and/or travel for long with mobile communities.

Based on a limited pool of data, it appears there are both health advantages and disadvantages to pastoralism. However, poor rural communities, whether settled or mobile, crop or livestock-dependent, tend to suffer similar problems: high rates of infectious diseases, malnutrition (particularly in droughts), and high infant, child and maternal mortality.[149] In addition, specific disease prevalence in any particular community is strongly influenced by the local environs, such as in a study from Mali, where nomads settled by water suffered high rates of malaria, bilharzia and a variety of parasite infections.[157] A review of Sahelian health research suggested pastoralists experienced higher infant mortality than settled communities.[158] Other studies have suggested that pastoralists, particularly men, suffered higher rates of zoonotic infections such as brucellosis and tuberculosis (TB),[152, 157, 159, 160], but correlations between zoonoses risk and pastoralism are variable.[26, 161, 162] Evidence also indicates that pastoralists suffer increased risk of respiratory, vaccine-preventable (typically when coverage is limited by poor infrastructure),[26, 152] and sexually transmitted infections (STI).[153, 157, 163, 164] Zinsstag claimed that pastoralists have generally poor health and almost always suffered from higher rates of the zoonoses brucellosis, echinococcosis, and rabies, as well as, depending on locale, trypanosomiasis, leishmaniasis, and plague.[100] However, Kenyan studies[149] on the impact of settlement concluded children of mobile pastoralists suffered less malnutrition due to higher livestock productivity and greater milk intake, than children in settled families, even those which owned livestock. This association held true during droughts, when researchers expected active pastoralists to face more difficulty. Similar correlations were found in Mali.[152] Nomadic women in Chad experienced higher rates of malnutrition during the dry season,[165] but as with other research, there was little difference between nomadic and settled children.[166] Settled pastoralists in Uganda experienced increased rates of epidemic diseases (hepatitis E, yellow fever, cholera, and meningitis) compared to mobile groups of the same ethnicity.[167] In Mali, lower rates of parasitic infections in mobile pastoralists were observed, but infant mortality was higher. Chabasse and Schelling working in Mali and Chad, respectively, found morbidities were similar in settled and pastoral communities.[152, 168]

A number of studies have indicated that mobility interferes with pastoral healthcare access and subsequent health status, but economic and social factors are important too.[158] An

investigation in Chad found social networks had both positive and negative health access effects for women, but religion created barriers for Muslim pastoral women specifically, because settled medical practitioners were predominantly male.[110] Pastoral women, regardless of faith, often need permission and support from their husbands before they can obtain healthcare.[169] Therefore gender may exacerbate health challenges associated with pastoralism.[26] Incomplete health data, combined with limited communication during travel, may impede healthcare service and delivery even when available.[26]

The needs of pastoralists, still neglected in many countries, may be low on national priority lists. Mobile pastoralists, especially in remote areas, have less access to infrastructure be it education, health, communication or legal. Delivery systems suited for settled communities are often inappropriate and/or expensive to provide for livestock-keepers on the move. Neglect, land loss, and historical conflict can also contribute to pastoral avoidance of government initiatives.[100, 170] Some studies have noted that pastoralism was correlated with delays in diagnosis and treatment for infections such as TB, hepatitis, and a variety of STI's[152, 171, 172] until illnesses reached advanced states,[158] in part because of clinic avoidance.

1.3.3 Wellbeing and Pastoralism

Wellbeing is variably defined and measured using a wide array of methods. Edward Diener, the "father" of modern wellbeing research (and developer of the widely used Satisfaction with Life Scale, SWLS), terms it simply happiness, or more formally, self-evaluated life satisfaction.[173] Dodge et al. explained it as "a state of equilibrium or balance that can be affected by life events or challenges".[174] Some research suggests people tend to have a "set" wellbeing to which they return even after major life trauma,[175] but other authors have challenged this "hedonic adaptation".[176, 177] Historically, little wellbeing research was done in the developing world, and even less in the poorest communities of low income countries.[178] Studies in poorer nations have increased in the past two decades, but when the term is used in low and middle-income countries (LMIC) research, it is rarely used in the academic sense. In *Staying Maasai*,[108] an important text on Maasai livelihoods in Kenya and Tanzania, it was often used to describe the economic status of entire households. This despite the fact that household measures may mask or omit variation in individual perspectives,[3, 143]

and general acceptance[3] that "…poverty cannot be conceptualized or measured in isolation from some concept of wellbeing."[179] Multi-dimensional poverty indexes that include wellbeing are now widely used to reflect the varying repercussions of poverty, for example by the United Nations Development Programme (UNDP) in annual Human Development reports.[180, 181]

It has been suggested the lack of wellbeing research in LMIC may be due to a perception that wellbeing is a lower, or even inappropriate priority compared with urgent survival pressures such as hunger and extreme income poverty.[182] It may also be incorrectly assumed that increased income automatically correlates to enhanced life satisfaction.[183] To the contrary, the small body of research that has been conducted in LMIC generally, and in poor communities globally, indicates that just as for the better off, wellbeing is multi-dimensional. Poverty affects self-assessed wellbeing, especially under conditions of serious material deprivation, but it does not preclude happiness.[184] Furthermore, some participatory research has found that community defined wealth-ranks tend to incorporate both material and psychological wellbeing rather than material or income-based comparisons alone.[3]

A single previous study on pastoral wellbeing as measured with the SWLS was conducted on Kenyan Maasai from the Siana Plains.[185] Other "wellbeing" studies reviewed were almost exclusively material or wealth oriented, although a recent qualitative study reported on differences in conceptual wellbeing associated with age and gender in a northern Tanzania Maasai community.[186] The Siana investigation was part of a larger study of three relatively isolated, materially "simple" cultures (the others were Inuit and Amish) comparing their wellbeing to industrialized societies. Researchers concluded that the Maasai were the most satisfied of the three communities studied.

1.4 The Potential of Livestock-based Development Initiatives to Improve Health and Wellbeing in Poor Populations (Africa/Pastoral focus)

1.4.1 Sub-Saharan Africa (SSA) in a Global Poverty Context

World poverty has more than halved since 1981. A recent review of progress on Millennium Development Goals (MDG) celebrated substantial successes in poverty reduction but highlighted rural location, lack of quality education (explicitly at the secondary

level), infrastructural deficiencies, and social exclusion as continuing obstacles in lifting those who remain most entrenched in poverty.[187] All of these factors are highly pertinent to pastoralists. Although poverty rates have dropped in every developing country and region, including SSA, by best estimates the absolute number living in extreme poverty has almost doubled in SSA, from 205 to 389 million people.[188] However, as 61% of countries in SSA lack effective national poverty measurement tools, it is difficult to assess the accuracy of cited numbers.[189] It is believed, though, that roughly half of the citizens of SSA, mostly rural dwellers, live in extreme poverty[190-192] and the region has consistently been a negative exception in global poverty trends because population growth overwhelms economic advancements.[14, 187] Predictions that one-third of the world's extremely poor would be living in SSA by 2015 have come true and been exceeded.[192] The extremely poor in SSA also suffered from a 21% poverty gap (the percentage living below the national poverty line) in the last available data, double the poverty gap of the next poorest global region.[191]

1.4.2 Poverty in Kenya

The Kenyan gross domestic product (GDP) is higher than average for the developing nations of SSA, and it is categorized as a LMIC.[193] However, World Bank (WB) country categorizations can mask high proportions of citizens living in poverty and the Oxford Poverty and Human Development Initiative (OPHI), locates 72% of the multidimensionally poor in middle income countries.[194] The Kenyan GDP growth rate increased from 3% to 7% between 2003-2007[190] but during roughly the same period, the proportion of poor almost doubled.[190] The GDP growth rate has stayed fairly stable since,[193, 195] and has overall contributed to a drop in national poverty. Most recently the OPHI ranked Kenya 85th out of 120 countries (a low numerical value corresponds to high poverty) on the Oxford Multidimensional Poverty Index (MPI) using data from the 2014 Kenyan DHS (based in part on a 39.9% national poverty, 14.5% severe poverty, and 12.9% destitution rate).[196] However, because of population growth and high rates of rural poverty, Kenya had the sixth highest absolute number of citizens living in extreme poverty.[197, 198] Significantly, it also has the second highest inequality ranking in East Africa,[199] and ranks ninth in Africa,[200] a probable consequence of a prioritization of urban over rural development[201] and extensive

corruption.[202-205] Major decentralization initiatives have been implemented in recent years, but rural Kenya is still substantially excluded from political decision making.[206] Corruption penetrates almost every level of government and development initiatives, exacerbating inequality and hindering inequality reduction efforts. The latest MDG report for Kenya showed that some gains had been made, but in many arenas progress was slow. Poverty, under-five mortality, and infant mortality rates were double the 2015 MDG target, while maternal mortality rate was triple the target.[207]

Rural poverty rates were higher than urban, 38.8 and 29.4% respectively in 2015/2016.[208] Because a high proportion of citizens live rurally (68%[209]), most of the poor (85%) and extremely poor (91%) are found in rural Kenya,[210] which was a focus region for the WB *Voices of the Poor* participatory poverty assessment. *Voices of the Poor* is 20 years old and did not include Narok district, but its findings were similar to those of the current work. Some relevant perceptions from poor Kenyans included: pessimism about the future, and a feeling that relative poverty had worsened; a belief that poverty was generational; a tendency for the wealthy to attribute negative and false stereotypes to the poor; and identification of fees-for-services as a contributor to increased difficulty in accessing education and healthcare. The research also concluded that FHH were disproportionately represented in the poor (20% higher rates than male-headed households (MHH)) and very poor categories (double the number of MHH on average) in every region surveyed.[211]

Pastoral poverty is predominantly associated with no/low livestock holdings.[144] Insufficient holdings can result from any or a combination of: generational poverty,[212] drought,[94] livestock disease,[94] raiding/thefts,[94] land loss,[94, 118] land privatization,[213] misfortune,[214] gender (female),[186] corruption,[120] sickness,[215] lack of resilience,[216] or decline of the social safety net.[147, 217, 218] Small herd owners tend to be more vulnerable and least able to recover from loss.[108, 214, 219, 220] Pastoralists are also often politically neglected and Kenya is no exception.[147, 221] Kenyan data suggests some of the highest poverty rates are in pastoral districts[95, 108] and northern pastoralists are among the worst off due to extra stressors of civil and cross-border conflict[222] (which has become increasingly weaponized with wars in the Democratic Republic of the Congo, Northern Uganda, Sudan and Ethiopia).[94, 223, 224] In contrast, in spite of many reports on increased pastoral poverty[14, 94, 115] as well as more than a

century of forecasts of pastoralism collapse,[225, 226] there is evidence to suggest that only some pastoralists are struggling.[94, 95, 108] Recent evaluations have also provided well supported claims for substantially larger national pastoral holdings in Ethiopia, Uganda, Sudan and Kenya than government figures suggest,[136, 227, 228] confirming results found in smaller scale research. These conclusions, however, are likely not mutually exclusive as research has also suggested increasing inequity in pastoral populations.[46, 94, 95, 108, 115, 218, 229]

1.4.3 Knowledge Gaps and Poverty in Narok County and Narok South Sub-County

Personal observations of unreported human and livestock morbidities and mortalities, and lack of adherence to national law in Olkoroi and surroundings over 14 years, suggested local representatives of the Kenyan veterinary, medical, educational and legal systems did not document rural events that might have been recorded in urban centres, in large part because they lacked monitoring resources. Specific examples related to reportable diseases (of both people and livestock), crime (including murder), education access, female inheritance, marital age and circumcision. Medical and veterinary officials in Narok town openly admitted that little rural data was gathered (the district is classified as 92.9% rural compared to a national average of 67.7%).[181] Law enforcement officers posted in Ololaimutia (a vehicle-hour away from Olkoroi) stated there was effectively no police presence in Olkoroi and similar communities. Even when data were collected, personal review of reports (from the Olkoroi medical clinic) revealed frequent tabulation errors, under-representative statistics (some residents rarely attended the clinic when sick), poor data security (two years of Narok District rural clinic reports were lost due to computer malfunctions when the district was sub-divided), and research could be shelved without analysis.[230] District Veterinary Office (DVO) officials stated that for the most part "the focus of the office is on major towns". They were also frustrated because "…there is no funding for recruitment, employment and deployment…" and simultaneously dismissive of the people they served:

> *An expectation that the poor villager might understand globalization is ludicrous. The World Bank believes that a Maasai citizen should understand what is a public versus private good. This is a person who doesn't perceive the consequence of sharing shelter [with livestock].*

In addition, officials were rueful, "…the truth is bitter…" and resigned "For us Africans, if it does not kill it is not a big problem." The DVO put the blame directly on the:

> *…West…industrialization…SAP [Structural Adjustment Programs]…The private sector has been promoted, but implementation of this strategy was premature and better sources of funding have not been developed. SAP have been destructive. With structural changes, the economy cannot bear the weight of all the sectors.*

A 2011 Kenyan inequality assessment[231, 232] ranked Kenyan counties[b] on a variety of health, education and infrastructure indicators. Narok ranked well on markers such as proportion of the population living below the national poverty line, and Narok South sub-county (location of Olkoroi) had similar rankings to the county as a whole. Narok was also the second most equal county nationally, with a Gini Coefficient of 0.315,[232] but ranked less well on education and health-related indicators. Malaria and TB frequencies for Narok placed it in the upper 1/3 of county rankings, but 25th of 47 for human immunodeficiency virus (HIV) prevalence, 22/36 for rural counties. County level infrastructure outside town centres was relatively poor,[231, 233] and average figures masked major within-county variations. Naikarra ward (where Olkoroi is situated), had the lowest proportion of citizens with primary and secondary education, and the highest with no education: at 81%, more than double than the best ward (43%).[231] Many small communities of Narok South Sub-County, like Olkoroi, had significant deficiencies in educational, judicial, medical, veterinary and sanitation services. Although it is one of the richest counties because of game reserve revenue, there were enormous rich-poor divides in Narok (raising some questions about inequality rankings), and it was widely believed that systemic corruption and revenue diversion were the primary reason for the lack of infrastructure.[234-237] Despite ranking forth of Kenyan counties for revenue generation, Narok County was also one of 14 counties which qualified to receive equalization payments from the Commission on Revenue Allocation (CRA) in 2015:

[b] After 2010 constitutional amendments, the highest level of geopolitical organisation in Kenya became the county, of which there are 47. The next level down are sub-counties, within which are wards.

> *'Only a few tycoons control the wealth of Narok,' CRA research and policy director Linet Oyugi told the Business Daily on Tuesday, adding that a small number of Narok residents benefit from the billions of shillings generated by the Maasai Mara.*[238]

Corruption affects income inequality and economic growth, and is a negative predictor of wellbeing.[239, 240] While it is difficult to find county specific information on corruption in Kenya, there has been documentation of corruption associated with land subdivision in Narok and Kajiado.[70, 118, 119, 241] *Staying Maasai*, which looked at Maasai household economies in Kenya and Tanzania, with a specific focus on livelihood, income diversification and the impact of conservation policy found, like others,[242] that corruption associated with game reserves and consequent lack of local benefit were the norm.[108]

1.4.4 Livestock and Poverty

Numbers are uncertain,[136] but it is estimated that more than a billion global poor depend on livestock for part or all of their food security and livelihoods.[6, 243, 244] Up to two-thirds of rural populations may be livestock-dependent, twice urban rates,[29, 79, 245] and pastoralists are the most numerous livestock-dependent peoples.[244] Just as it is difficult to accurately determine the number of livestock-dependent poor, it is also challenging to enumerate their livestock: estimates range from 1-20 billion.[246, 247] Livestock keepers typically earn one-fifth to one-half of family income from their animals, though pastoralists often derive more, and "pure" pastoralists may survive on livestock alone. Up to 95% of keepers in some developing countries live below national poverty lines,[246] and in SSA, home to more than 400 million poor livestock-keepers, roughly 85% live in extreme poverty.[243]

Unfortunately, as recently as 2003, most national Poverty Reduction Strategy Papers (PRSP's) ignored the role of livestock in the lives of the poor, the potential of livestock for poverty alleviation, and the contributions of livestock to national economies. Only four of 49 available PRSP's in a 2003 review contained detailed strategy and budgetary consideration of livestock, an omission that was passively encouraged by the International Monetary Fund (IMF) and the WB which required no substantive consideration of livestock or other resource sectors typically important to the poor.[248] In addition, the self-identified needs of poor livestock keepers have not been effectively documented, and neither are the positive nor negatives impacts of livestock on the health of the world's poor well understood. Both needs

and health effects are likely variable both between and within countries. Lastly, what is prioritized in academic literature about human health-livestock relationships of poor livestock keepers (zoonoses, for example) does not always accurately reflect the real-world priorities of academics and/or poor livestock keepers.[249, 250]

According to Heffernan:[22]

> *...poor livestock keepers are those who are economically and/or socially **at risk** and whose animals, at most, provide subsistence or the minimum augmentation of daily nutritional requirements...a poor livestock keeper does not own enough livestock to meet basic subsistence needs, yet depends upon his or her livestock.*[22]

The word "risk" highlights the vulnerability of those who own insufficient livestock to support family needs, to diversify, to improve their SES,[66, 130] and/or to facilitate escape from poverty for their children (as per *Voices of the Poor*). In addition, they are more vulnerable to complete loss of holdings and descent into extreme/persistent poverty if disaster strikes.[130, 251, 252] Pastoral research has shown that significant livestock loss is associated with major risk of severe and chronic poverty and reduced health indices for adults and children.[215] Nonetheless, livestock are also an important potential pathway out of poverty. A study of 1706 households in two Western Kenya communities, found 42% of families who escaped poverty in the preceding 25 years did so via livestock-based diversification.[253]

1.4.5 Livestock in Kenya (focus on pastoralists)

As is the case across Africa, agriculture is critically important to the Kenyan economy employing approximately 60% and 80% of the total and rural population respectively. Agriculture generates 51% of the GDP, 24% directly and 27% indirectly,[254] however, the economic contribution of livestock has been significantly underestimated since colonial times.[95, 136, 255] In 2009, the International Authority on Development (IGAD), an 8-member East African trading bloc, concluded the value of livestock to IGAD nations may be 150-350% higher than official government estimates, depending on the country of focus.[136] For Kenya, the revaluation was 2.5 times official estimates, and, at approximately 350 billion Kenyan Shillings (KSh), roughly on par with crop-based contributions to the agricultural GDP, estimated to be worth 410 billion KSh.[256]

It has been estimated that pastoralists are two-ten times more productive per land unit than any other system advocated for ASAL.[14, 99] The lack of current, accurate, pastoral demographic data,[95] however, makes even rough calculations of productivity difficult. In Chad, it was suggested pastoralists produced up to 15% of the GDP despite constituting less than six percent of the population.[100] In Kenya, pastoral population size is between eight-ten million.[257] Population estimates combined with production data[136] imply pastoralists could be generating as much as 20% of the Kenyan agricultural GDP, roughly proportionate to their population size. Since pastoralists make other economic contributions, most prominently in tourism, their contribution may exceed their proportional demographic.

Kenyan livestock productivity has been perceived as lower than its potential since the colonial era, and initiatives to increase output have targeted different producers and stages of the production process, from disease control[1] to fattening pens and slaughterhouses.[258] As already noted, these initiatives have rarely been successful, especially in pastoral regions.[24] Some of the most commonly cited reasons for failures include: underfunding of the livestock sector in favour of plant-based agriculture;[259, 260] a focus on medium and high intensity[108] and/or large-scale production systems or services/models for such systems (for example disease free zones),[260] which excludes the majority of Kenyan livestock producers; inability of most producers to meet Western standards of product quality, thus preventing Kenya from accessing lucrative export markets;[255, 260] tariff systems that prevent nations like Kenya from even potentially penetrating Western markets;[260] widespread endemic and periodic epidemic livestock diseases,[29, 94, 260] insufficient veterinary resources to serve most rural populations, and since the SAPs of the 1980's and 1990's, difficulty in accessing privatized veterinary services;[108, 114, 261, 262] promotion of breeds and technologies ill-suited or unavailable to most of the nation's smallholder or rural producers;[8, 255, 263] and, lastly, not only lack of support for, but a long-standing prejudice against pastoral producers.[108, 260]

Livestock productivity barriers in Kenya, as listed above, are many and diverse. From a human health perspective, one of the most important is veterinary resources, because of their potential impact on animal health which in turn has multiple effects on human health. Recognition of the potential of veterinary services to improve global public health led the Office International des Epizooties (OIE aka World Organisation for Animal Health), to

include One Health[c] in all OIE Performance of Veterinary Service (PVS) evaluations, as of 2013.[265] U.K. Department for International Development (DFID)-funded research in Kenya found veterinary costs were a barrier for the poor, but accessibility was the most significant impediment. It was also noted that knowledge about effective use of veterinary drugs was lacking in both the non-veterinary vendors and keepers. Inappropriate use of veterinary medicines has the potential to cause negative health outcomes to both livestock and their owners, and evidence suggests such problem already exist.[266-268] The DFID research further observed wealthier livestock owners were more able to access and benefit from veterinary services, and study participants felt veterinary professionals favoured the wealthy.[245] Since poor keepers have fewer resources for treatment, and are likely to experience proportionally higher livestock morbidity and mortality, better livestock disease control could increase national productivity and simultaneously contribute to poverty alleviation.

Poor veterinary infrastructure in Kenya additionally precludes accurate assessment of livestock disease frequencies, including zoonoses, and official records significantly underrepresent true rates. Both the World Health Organisation (WHO) Global Burden of Disease Report (GBD) and OIE collect some information on zoonoses but fail to report on a number of zoonoses important to the developing world. A 2013 publication reported that of more than 600 known zoonoses, at least 100 are of medical significance world-wide, but the GBD reports on only 11 and OIE, 13. Similarly, many livestock diseases are found in both richer and poorer regions, but those endemic and unique to developing nations are often neglected in research.[269] In 2012 it was estimated that 99.99% of all livestock mortality in Africa was not being captured in official OIE reports and records.[79] In addition, only three African nations have surveillance programs to monitor antibiotic use in domesticated animals.[268] For this thesis, when livestock morbidity and mortality reports were requested from the Narok DVO in 2008, most months contained little or no data. Although the WB was in great part responsible for deterioration of veterinary services in many African countries, it

[c] One Health is a health model that seeks to combine human and veterinary health knowledge and resources in research and intervention initiatives for greater effectiveness, especially in resource-poor settings. 264. Bardosh K. One Health: science, politics and zoonotic disease in Africa: Routledge; 2016.

is now exerting pressure along with other agencies, on these same nations to improve veterinary capacity.[269] Reinvestment in veterinary services, especially through a One Health model, could improve human health both directly through dual service delivery but also indirectly due to a reduction in zoonotic disease transmissions, increased productivity and consequent improved SES.

In writing on the lack of consensus in defining poverty, Akindola noted poverty creates deprivation in many realms that in combination reduces human capital, further elaborating that to allow "experts" to define poverty based on economic measures alone must result in an inevitable failure to capture the full experience of the poor. He also suggested that it may be necessary to define poverty according to local experience because "What constitutes poverty for one individual, for example, is not necessarily the same for another".[270] In the context of pastoralism wherein livestock play a multidimensional role that goes far beyond a source of livelihood, veterinary deficiencies affect more than household revenue. The predominant focus on productivity improvements and livestock as a pathway out of poverty without consideration of the centrality of livestock to pastoral life is another form of pastoral undervaluation.

1.5 Existing Reviews of Livestock Based Interventions

There are numerous widely cited papers and narrative reviews on the potential impact of livestock-based interventions on human health and wealth.[9, 16, 29, 79, 271-275] Although some include consideration of internal and external barriers to livestock-based poverty alleviation, there are very few systematic reviews on the topic.

The well-known, non-systematic but extensive *Livestock in Poverty-Focused Development* (LID) review,[16] assessed trends and causes of failures in livestock-based development, and is still highly relevant. Most of the projects reviewed were not specifically poverty focused, but those that were generally had a positive, albeit modest impact. Technological and service oriented projects were the most common but frequently, technology either did not reach target communities, or, when it did, was inappropriate for poor recipients and more likely to benefit already privileged community members. The LID team also reviewed organisational and institutional projects. The former also had a high

failure rate, primarily because they were not economically viable without external funding, or new initiatives were not ultimately integrated into existing frameworks. Institutional projects, however, though relatively small in number, showed promise (the approach was relatively new at the time of the review). An example of such a project is the Oxfam Wajir Pastoral Development Project which ran from 1994-2003 in Northern Kenya and worked with communities affected by drought and ethnic violence. The initiative successfully increased average pastoral incomes through support for the formation of pastoralist associations which became models for similar organisations across East Africa. The project plan explicitly aimed to and succeeded in incorporating multiple levels of government in a dialogue and process of peace, community development, service improvement, and poverty alleviation.[276]

Another non-systematic review, by Wanyoike et al. (2011), assessed a random sample of livestock development projects. Performance indicators were based on development agency criteria. Cluster analysis was used to differentiate successful versus unsuccessful projects, and identify determinants of success. It was concluded that project size, participant diversity, incorporation of institutional development, and effective monitoring and evaluation were important predictors of success. Inconsistency on the part of government collaborators and inclusion of non-livestock focused initiatives were associated with project difficulties. The authors concluded that 60% of the reviewed projects had failed.[277]

Three systematic reviews of interventions related to livestock and the poor were located. Although the first, *Community animal health services for improving household wealth and health status of low-income farmers*[278] concluded that eight of 14 projects reviewed had produced identifiable improvements, only two measured outcomes that directly affected farmers. None of the projects considered gender or initial SES, and it was noted that methodological quality, study design and sampling strategies were variable and unclear, hindering study comparisons. Only five of the studies had clearly described outcomes. A Cochrane Review protocol (2002) and updates (2006, 2011) by the same group with the same title, sought to include only individual, cluster and quasi-randomized controlled trials and controlled before-and-after studies on the topic, but remained a protocol only (given the paucity of literature in the field). The second review *A review of the effectiveness of agriculture interventions in improving nutrition outcomes*[279] only included two livestock

studies. Authors again found it difficult to compare studies across different study designs and interventions, and reported that study designs were often inappropriate for determining cause-effect relationships. The last review *Can Interventions to Promote Animal Production Ameliorate Undernutrition?* [280] also found major limitations in study design, evaluation and analysis, and a lack of statistical testing and analysis in many studies. The authors noted that little attention was paid to intermediate outcomes which can be important in explaining how interventions have their effect. They concluded that better designed studies with appropriate evaluation of intermediate outcomes were required to properly understand the potential and mechanisms of livestock-based productivity interventions.

Publication bias undoubtedly influences published reports (reports of failure may exist only in the grey literature[281]), especially given that interventions are often funded by non-governmental organisations (NGOs) and development arms of national governments.[282] Nonetheless, there is evidence to suggest that research, projects and intervention designs do not adequately incorporate concerns of targeted populations, success rates are not optimal, and successful interventions do not always reach those in greatest need.[283] Specifically, within poor communities there are often differences in relative effects between more and less advantaged populations such as women,[284, 285] culturally excluded groups, or those in the lowest socioeconomic categories.[286] In 2015, given the scarcity of available reviews, I conducted my own literature search on the effectiveness of livestock-based interventions to improve wellbeing in the poor. No time limits were set on publication dates and outcome terms were selected to include potential health, economic, knowledge and social benefits. More than 1500 academic publications were extracted from Medline using four basic conceptual search terms: poverty, livestock, interventions and outcomes, and no time limits on publication dates. Boolean logic searching capacity, keywords and medical subject heading (MeSH) were used to optimise sensitivity and specificity. Only 16 papers attempted to measure health outcomes for human participants as well as livestock-related productivity and health outcomes. Many of the reviewed papers were theoretical only. Of the 16 relevant papers identified, three did not explicitly measure human outcomes reporting only descriptive conclusions, and four measured only financial outcomes. Furthermore, only: four had a control arm, four had considered SES, three followed up longer than a year, and one included

gender in study design and outcomes. Methodology, communities and livestock types investigated were highly variable making comparisons extremely difficult. Although the initial papers examined were from Medline only, and therefore potentially excluded more agriculturally oriented articles, searches of other sources such as AGRIS, Ag-Econ, and Agricola, yielded few additional articles.

The most recent relevant review, *Evaluating one health: Are we demonstrating effectiveness?* (2017), specifically examined One Health oriented literature published between 2003 and 2015 using abstract search terms which captured "One Health research, action (e.g. collaboration, surveillance, zoonotic disease control program integrated across animal-human-ecosystem interface) or case studies". As in my own search, although a large number of potentially relevant articles met the initial search criteria, only seven of 1839 papers included any quantitative measurements of outcomes. The authors concluded there was a significant lack of evidence to support the claims of One Health proponents.[60]

1.6 Research Goals and Objectives

The overarching goals of this thesis were three-fold. Firstly, to develop a data-informed understanding of the relationship between pastoral livestock and owner health via a longitudinal health study on both keepers and their livestock simultaneously. Secondly, to both prioritize the perceptions and values of the community and illuminate the quantitative data through a series of cross-sectional surveys on psychological well-being, disease priorities, and livestock rearing practice, with an emphasis on possible gender differences in perception and practice. Thirdly, to develop a series of exploratory statistical models to describe key livestock and human wealth and health outcomes. A literature review was performed and data was collected via an in-depth, participant-informed, mixed-methods investigation of a single, rural, traditional Maasai community, Olkoroi, in South-West Kenya according to the six primary research objectives listed below:

1. To review the literature on livestock health, welfare, and productivity, livestock-mediated development projects, and livestock-human wealth, health and wellbeing relationships in poor and/or traditional livestock-keeping communities, with a primary focus on Sub-Saharan Africa (SSA), pastoralists and the Maasai.

2. To develop a detailed demographic, socioeconomic and cultural understanding of individuals, households, community structure, wealth perceptions, and livelihoods of Olkoroi in order to most effectively understand and assess how livestock-keeper relationships varied along social gradients in small, rural communities such as Olkoroi.
3. To identify Olkoroi human and livestock disease priorities, livelihood challenges, and explore individual selection and evaluation rationales.
4. To compare longitudinal, self-reported household livestock and human morbidity to Olkoroi clinic reports, district medical reports, community disease priorities, and the pastoral literature.
5. To assess individual psychological wellbeing within the community and compare wellbeing between the sexes.
6. To use the data collected to build models to identify the household and livestock variables that explained the most variation in individual psychological wellbeing, herd size, young livestock growth, herd and human household health status.

1.7 Livestock-Based Interventions: Opportunities and Challenges

Livelihood is inextricably associated with health in a bidirectional manner. Capacity to sustain livelihood is strongly affected by health status. Globally, but particularly in poor countries with weak social services, ill-health is one of the most common routes into poverty.[287] Conversely, livelihood affects health through multiple pathways from remuneration to occupational exposures and corresponding risks for chronic and infectious diseases, as well as physical injuries. Agriculture is particularly important as a determinant of global health for both agricultural workers and consumers of the sector's products. In richer nations, less than five percent of the workforce is now found in agriculture.[288] In SSA, agriculture employs 60% of the population, and, according to the FAO, drove 50% of job growth between 1999 and 2009.[289] Despite these strong links, health and agricultural domains do not always engage cooperatively or effectively to optimize health.[290] Although One Health and Ecohealth research paradigms have gained prominence beginning with avian flu pandemic concerns in the early 2000s, resistance to veterinary and medical collaboration

continues to be a problematic obstacle to productive integration of health concerns of livestock keepers and their animals.[264] Interdisciplinary engagement emphasized in Ecohealth, and necessary for such integration, particularly the inclusion of social scientists who might help to bring the voices and priorities of keepers to the fore, is also limited.[264]

Barriers to attainment of livelihood security for the livestock–keeping poor include concerns such as acquiring, maintaining and retaining livestock, optimising productivity, and accessing effective marketing opportunities.[16] For most pastoralists there are additional challenges of coping with marginalization and climatic variability which appears to be worsening due to GCC. Given the current diversity of problems faced by the poorest pastoralists, recovery from periods of drought and disease may be becoming more difficult. FHH may also face gender restrictions that affect accessibility of livestock-keeping resources (including the first step of livestock acquisition) and/or participation in capacity/productivity improvement initiatives. Research indicates, for example, that women are much more likely to be excluded from producer organisations[291] which help to strengthen smallholders through increased group production and market impact.[292]

Although there is little specific research on the relationship between livestock health and/or productivity and the health of pastoral keepers,[27] a wide variety of studies on pastoral productivity have identified a number of variables associated with herd size and resilience (resilience referring both to continuation of pastoral tradition, as well as ability to maintain herds through, and rebuild after drought and/or disease epidemics). Critical correlates include: family size, household composition, shifting gender roles, education, diversification, land ownership, and geographical location.[108, 219, 293-297]

Livestock associated human health hazards can increase risk and vulnerability to poverty in a potentially downward spiral.[290] It has been claimed that reduction or, if possible, zoonoses elimination would have a significant impact on the most vulnerable.[14, 29] If true, simply tackling endemic zoonoses could theoretically result in a dual investment benefit of reduced human and livestock morbidity and mortality. A significant improvement in the health and productive capacity of poor livestock keepers could additionally improve earning capacity in part through enhancement of the health, productivity and consequently value of their livestock assets. Unfortunately, with some exceptions, (for example current efforts to

control rabies, and the successful eradication of rinderpest) global priorities and research investment tend to focus on outbreak diseases that pose potential threats to rich nations such as Ebola and Avian flu.[264] A further complication is that in practice, zoonoses rarely appear in self-reported lists of the challenges faced by poor livestock keepers. A number of studies on the pastoral perspectives on zoonoses have concluded pastoralists do not prioritize or even recognize zoonotic illnesses within their health landscape.[29, 298-303]

Development projects have frequently been predicated on developed world agriculture, leading to the repeated introduction of large scale, high intensity production systems,[24, 248, 291], many of which have failed.[24, 291] There is also an ongoing tendency to prescribe intensification of smallholder and extensive production systems as the best route out of poverty[255] despite evidence to suggest smallholders can be highly efficient even using traditional practices.[291] Suggestions of intensification are often unrealistic, particularly when applied to livestock-based systems like pastoralism where: livestock play a multiplicity of roles, some of which could be lost with a shift in production mode; intensification is initially expensive and requires speciality breeds, feed and resources which are unaffordable for most poor livestock keepers; national veterinary systems already fail to meet needs of poor livestock producers and high intensity systems usually need greater veterinary inputs; poor producers commonly live in relatively isolated regions that are impractical as locales of intensification due to potential environmental harm to fragile ecosystems, expense and lack of infrastructure; and many rural producers face obstacles due to illiteracy, which already causes harm due to misuse and overuse of various pharmaceutical products and tools.[304-307] In addition, given that pastoralists appear to already be much more productive and contribute significantly more to national economies than they have been given credit for, it might be more effective to find culturally and location specific mechanisms to address problems faced by existing production systems rather than try to impose western production methods.

Fundamentally, even though livestock-based poverty alleviation interventions have been promoted for over a century now, significant challenges and knowledge gaps remain:

1. Many governments still appear to lack interest and/or awareness of the economic importance and contribution of their low-input, traditional livestock producers, and

continue to ignore their perspective even when making decision which may have major impacts on their livelihoods.

2. There are still enormous knowledge gaps, and a serious lack of comprehensive, quality data on relevant populations, from basic human and livestock demographics, to productivity, morbidity and mortality statistics in livestock and their keepers.[79, 80, 308] There is insufficient data on many neglected tropical livestock diseases and the complexity and diversity of livestock diseases-human wellbeing relationships make it very difficult to draw conclusions on how to prioritize and effectively address the problems they create.[27, 264, 275]
3. While there are many intervention studies, most are so highly variable in quality, measurement tools, and study design that they cannot be used for systematic reviews. Even the higher quality studies are so diverse it is basically impossible to draw any clear conclusions on intervention efficacy or to make comparisons between studies. Furthermore, most intervention studies use designs that are highly prone to bias, lack long term follow-up and consideration of socioeconomic variability within communities or consideration of gender factors in intervention outcomes.
4. There are few models to assist in predicting economic, health and wellbeing impacts of different interventions. Proposed interventions, whether small or large, rarely have goals beyond economic improvement. Measurement of benefit distribution or concrete health outcomes is often omitted, and the impact of increased revenue on cultural and social aspects of participating communities is rarely considered.
5. There is a lack of consensus on which diseases, whether livestock specific or zoonotic, should be the focus of interventions. Without consensus, it is difficult to prioritize interventions appropriately. To complicate matters further, controlling high impact diseases does not always produce high impact outcomes due to issues of feasibility and costs. Lastly, there is often priority disagreement between livestock keepers and "experts". Effectively it is not really known which diseases matter the most, nor is it agreed as to who should make priority decisions.[29]
6. There is no clear agreement on how best to support poor livestock producers, in great part because of lack of comprehensive data, and lack of agreement on priorities.[264]

1.8 Thesis Overview

This thesis is structured with seven chapters. The first chapter provided background on the current status of traditional livestock keepers with a predominantly African perspective and a specific emphasis on Maasai pastoralists. The contribution of livestock to Maasai livelihood, SES, wellbeing and health is described as well as the position of the Maasai within the Kenyan political system. Chapter one also included an overview of rural poverty in Kenya, the significance of livestock to the global poor, and the contributions of livestock to the Kenyan GDP. The chapter concluded with a discussion of the reasons that livestock-based development initiatives have been mostly unsuccessful for over a century and highlights the knowledge gaps which continue to be a barrier to more effective use of livestock to improve the wealth, health and wellbeing of poor livestock keepers.

Chapter two details the research methods used to collect data for each of the following chapters three-six, and the analytical approaches used to interpret the data.

Chapters three-six present the main results for each component of the research with a discussion, illustrated by quotations extracted from the qualitative semi-structured interviews. Chapter three reports on the descriptive epidemiology of Olkoroi including community resources, household structure and SES, culture, and livelihoods. The data described were also used in model building for chapters on livestock and human health and wellbeing. Olkoroi characteristics are linked to the larger body of research on the Maasai.

Chapter four presents the conclusions of community focus groups on wealth markers, cluster analysis of household wealth markers, the results of exploratory modeling of psychological wellbeing, and gender differences in self-reported perspectives on wellbeing.

Chapter five describes self-reported perspectives on livestock-based livelihood including livestock duties, the contribution of livestock to wellbeing, livelihood constraints, and livestock disease prioritization and understanding. The results of three exploratory analyses to describe HoH and household-level variables most strongly associated with the size of household livestock holdings, young livestock growth rates, and self-reported livestock disease prevalence are discussed.

Chapter six reports on the results of a baseline cross-sectional community health survey, describes health promotion behaviours, and human disease prioritization and understanding. Comparisons are made between district level, and self-reported disease frequencies. A final set of human health exploratory models identifies variable most strongly associated with child and adult total infectious disease burdens, as well as incidence of the most commonly reported individual disease categories: malaria, respiratory infection and gastrointestinal (GI) illness.

Chapter seven is a summary and integrated discussion of the most important finding of this research, unique contributions, and recommendations for future research and intervention development.

Chapter 2: Data Collection and Analytical Methodology

2.1 Setting, Population and Ethics Approval

Olkoroi is a small, traditional Maasai community situated in Naikara Ward, Narok Constituency South, Narok County, Kenya (latitude and longitude, 35E 1.7S). Ecologically, Olkoroi is located in typical savannah, but has access to a year-round water source. As a result, while dry and drought periods severely impact crops and livestock, the human population is always able to easily obtain water for basic needs. The community strongly identified as traditional pastoralists, but most households were in permanent residence, particularly families with younger children who attended the local primary school.

Approximately 75 households lived in Olkoroi, comprised of 459 individuals, 150 adults and 309 children. Roughly forty children attended boarding school but returned for holidays. The ratio of women to men was 1.5:1 (on average, 91 women and 59 men), due primarily to polygamy, but also because of a traditional age gap at marriage which frequently lead to early widowhood. Three quarters of livestock-owners moved their animals due to drought or seasonal pressures, but the community size remained relatively stable because when animals were moved, they were often left with relatives or hired herders. Therefore, even if HoH moved their animals, they did not usually stay with them for a prolonged period.

Consent of Olkoroi adults was 100% for participation in the research, with two exceptions in 2008 (the first year of data collection): only 63% (95/150) participated in the cross-sectional health survey, primarily because it was carried out by a Canadian volunteer nurse who was new to the community, and only 45% (67/150) provided blood samples for hematological tests, because of widespread suspicion of unauthorized and surreptitious HIV testing by medical professionals in Kenya. Full participation occurred for all other studies. When residents were away during longitudinal data collection, their information was excluded until their return. Those absent for cross-sectional studies completed interviews when available, however total participation varied because of death (3.3%), marital conflict (1.3%), community exclusion (2%), and residence in more than one geographical location (2.7%). All data on children was obtained through parental interviews, primarily maternal.

Ethics approval for the research was given by the UBC Clinical Research Ethics Board (H07-02752) and the Kenya Medical Research Institute (Non-Scientific Steering

Committee Protocol Number 164). I was an official affiliate of the International Livestock Research Institute (ILRI) for the duration of my research, through which I was granted permission to engage in livestock-related research in Kenya (ILRI has blanket research clearance under a host country agreement with Kenya). In addition, I completed both the UBC Experimental Animal User Training, and the Human Ethics Training programs. Household consent to research participation was obtained in February 2008. HoH were contacted, and the consent form reviewed in Swahili or Maa. Agreement was documented by signature or thumbprint (the norm) on the form, and a Swahili copy was left with the family.

2.2 Research Development, Field Work Timeline, and Field Assistance

The studies described in this thesis were carried out from January 2008-December 2010. Because I was employed full time for the duration of my research, I personally carried out data collection over three field seasons from January-April 2008, May-August 2009, and October-December 2010. I was present for all cross-sectional studies, and longitudinal data collection in the three field seasons, with the exception of physical assessments and related questions that were part of the 2008 baseline health study (which was carried out by a Canadian, volunteer, qualified nurse). When I was unable to be in the community, my field assistant, Alfred Koshal, was responsible for maintaining the longitudinal studies.

The initial research plan was to conduct five studies: focus groups to identify locally relevant wealth markers; a sociodemographic survey of household history, structure, and capital; a cross-sectional survey of household health and health-related behaviours with an emphasis on zoonotic risk factors; a baseline cross-sectional livestock health survey, and a longitudinal human and livestock health study. The cross-sectional household studies were to be carried out in Olkoroi and three surrounding communities: Laleta (to the east of Olkoroi), Ilkisaruni, and Oltulele (to the south), and completed in the 2008 field season. The longitudinal study was to begin in 2008 and run for two years.

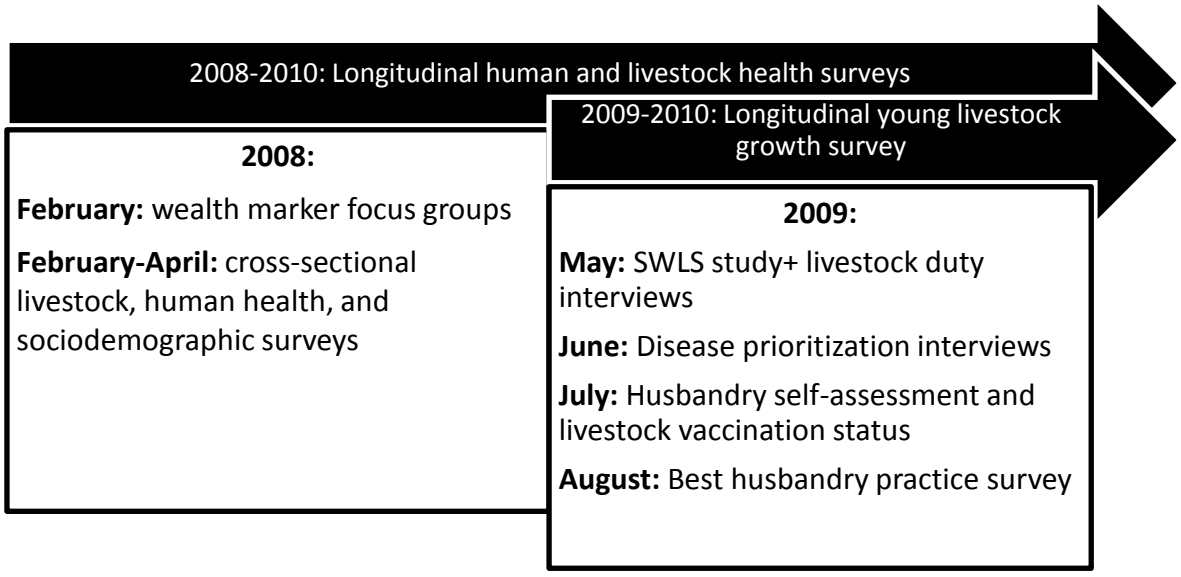
However, in 2008, a number of significant research issues became almost immediately obvious. The first was that it would not be feasible to collect longitudinal data from all four local communities with the time and resources available. Therefore, when the longitudinal study was initiated in May 2008, it focused only on Olkoroi households.

Secondly, household wealth and individual physical health would not likely fully describe individual wellbeing, particularly as regarded possible gender effects. Additionally, as we conducted the cross-sectional livestock health survey, and also interacted socially with the community in 2008, we received numerous owner reports suggesting young livestock morbidity and mortality rates were high, potentially having an important effect on herd productivity. The demographic survey also indicated significant variation in size of livestock holdings and a high proportion of households with no livestock.

To address these concerns and better capture the diverse influences on human and livestock health, six cross-sectional studies were added to the 2009 field season, and a second longitudinal study, of young livestock growth, was initiated from May 2009-December 2010. These studies were also carried out in Olkoroi only. The additional cross-sectional studies investigated: past and/or current responsibility for livestock-related duties in household adults (HoH and any affiliated adults, for example unmarried sons, sons and daughters-in-law who lived in an extended family unit, or widowed parents), adult life satisfaction via the SWLS (Satisfaction with Life Scale), prioritization and understanding of livestock and human disease, livestock vaccination status, self-assessment of household husbandry, and opinions on best husbandry practices for optimizing livestock productivity.

My primary field assistant throughout the research was Ole Alfred Leroka Koshal, a long-time local resident whose father was one of the first settlers in Olkoroi. Ole Koshal was fluent in Ma, Swahili and English, and collaborated on all field work except the cross-sectional human health assessments, maintained the longitudinal data collection while I was in Canada, and did the majority of interview translations. A volunteer Canadian nurse accompanied me in the 2008 field season and performed the human health assessments. A number of individuals provided brief periods of assistance with tasks ranging from translations, filling in for Ole Koshal on rare occasions when he was unavailable during my field seasons, organization of the preliminary focus groups, community meetings to discuss the research, and coordinating the end-of-research livestock vaccinations.

Figure 2-1: Research timeline



2.3 Qualitative and Mixed Methods Data Collection

2.3.1 Personal Record Keeping and Informal Community Perspectives

The semi-structured nature of much of the data collection, and community interest in the research, meant that respondents often added commentary or elaborated on their perspectives, with or without prompting. Open-ended interviews except the wealth focus groups, were voice recorded with participant permission (SWLS/livestock duties, disease prioritization, and best practice interviews). Other data collection was translated/transcribed at the time of the interview. Informal conversations on market days, during data collections, and home visits outside research activity provided further perspectives on individuals, families, local culture and livelihood practice. I was frequently invited to community meetings about the school, or celebratory events such as weddings, church activities, and fundraisers, and also hosted community meetings about my research in each field season. Detailed notes were taken at or following all meetings/events, for research and/or personal record-keeping and reflection, and I kept daily field journals in which I recorded events and interactions of interest. Data collection entailed visiting every community home every week while in the field, and I made field notes throughout each research day. We were often asked to have tea during data collection and discussed various aspects of research as per home-

owner's interests, at such times. Other forms of community engagement occurred via interactions with students and teachers (my own children attended Olkoroi Primary for two months, and my oldest daughter and I taught occasionally in the school), and discussion with over 250 women from Olkoroi and adjacent villages during interviews associated with a livestock-based women's microcredit organisation (since 2004). I continue to correspond regularly with residents into the present and am usually notified about significant events such as the progression of land subdivision, criminal activity, serious livestock morbidities and mortalities, human mortalities, and major weather events.

Throughout the following chapters quotes from research interviews (predominantly the SWLS/livestock duties interviews) and a small number of informal conversations are used where they provide community perspectives which relate to data interpretations. The specific source is identified with each quote. No thematic analysis was done of qualitative/mixed method responses, though answers were grouped into categories for the purpose of comparisons and analysis.

2.3.2 Single Interviews with CMF Employees and District Officials

Perspectives and practices of relevant government employees, officials, and representatives of CMF were obtained via open-ended interviews in 2008, but also through observation, and interactions over the research period. As these interview were conducted in English, they were transcribed at the time of the interview. The individuals interviewed and the specific interview focus were as follows:

- The Olkoroi head teacher (principal) was asked in 2008 about the structure of the Kenyan education system, school funding sources, sex ratios at the school, exam performance, government staffing provision, and challenges associated with education delivery in the community.
- The Olkoroi clinic nurse was asked in 2008 about: his background, training and clinic responsibilities; the most common health problems in the region; services provided by the clinic; and solutions or approaches that could help to improve community health. In addition, the Canadian volunteer nurse was given permission to document the clinic pharmaceutical and equipment resources.

- The directors of CMF Narok (one of whom was from, and had practiced as a nurse in Olkoroi after CMF training) were asked in 2008 about: CMF history, mandate, operational locations, and specific activities in the Maasai Mara; organizational and funding structure, and relationship to the Kenya Ministry of Health; the most serious problems seen at both the Olkoroi and Ewaso Gniro clinic in Narok town (the biggest CMF clinic); and human health concerns related to livestock.
- Officers from the District Public Health (DPH) and Medical Office (MO) were asked in 2008 about: the position of their office within the Ministry of Health infrastructure; office funding; and the biggest regional challenges for the office.[d]
- Officers from the District Veterinary Office (DVO) were asked the same questions as the DPH and DM officers, but also about: services provided to rural areas; liaisons with other district offices and agencies; and zoonoses focused program delivery. In addition, there were numerous posted flip-chart sheets from a recent brainstorming exercise (on office performance, potentials, and challenges) which I was allowed to copy. The veterinary officers were much more engaged and interested than the DM and DPH officers and extemporized widely.

Additional perspectives were obtained when visits of government officials to the community overlapped with my time in residence (for example the assistant chief for the Naikarra subdivision provided information about his official responsibilities and local law on brewing alcohol, and informal conversations were had with District Education Office officials about responsibilities and challenges of education delivery). Similarly, conversations were held with the community missionary whenever he and I were present in Olkoroi simultaneously, and he also provided his written perspectives on community health and wellbeing, by email in October 2008.

[d] Access to these officers was very limited and the interview, of necessity, brief.

2.3.3 Wealth Marker Focus Groups

At the beginning of the 2008 field season, separate groups of eight men and eight women, were simultaneously interviewed to obtain community identified wealth indicators associated with an a priori list of socioeconomic characteristics from the literature combined with community observation (some standard literature markers were not relevant). Participants were selected based on consultation with an informed community member, a Maasai primary school teacher who had lived in Olkoroi for two years. Residents from all SES levels were invited. Discussions were concurrently translated and transcribed.

The list of SES characteristics was sequentially reviewed with each group. Participants were asked to identify possessions and practices associated with each characteristic which distinguished the wealthy, the coping (those who could meet basic needs but did not have extra resources), and the poor (those who struggled to maintain their households). The indicators discussed were: diet composition and sufficiency, health, income, employment, modes of transportation, educational of HoH and children, veterinary and medical access, livestock ownership, marriage/family composition, housing, clothing/footwear, household furnishings and energy sources (for light, cooking, and devices such as cellphones).

2.3.4 Livestock duties/SWLS/Wellbeing interviews

The livestock duties script, the SWLS, and wellbeing questions can be found in Appendix B Household adults (n=150) were first asked whether or not they participated/had participated (for "retired" adults) in a list of nine livestock duties compiled from observed, routine livestock tasks performed by community members, and potential routes of zoonotic exposures: herding, disease diagnosis, disease treatment, livestock buying, livestock selling, milking, slaughtering, butchering, and assistance with livestock births.

Following the duties interview, respondents were asked to self-assess their life satisfaction via the SWLS.[309] The SWLS poses a series of five statements to which respondents are asked to rate their agreement on a Likert scale of one-seven. An overall measure of wellbeing is obtained by summing the total numerical responses. After the initial numerical rating, participants were asked to consider their life and identify the most important positive and negative contributors to their current wellbeing, then asked to think

about their future and identify what they thought was most likely to positively and negatively influence their future wellbeing. Participants did not have difficulty with the SWLS, however, when asked about contributors to and detractors from wellbeing, the first participant interviewed had some difficult grasping the scope of the question. In collaboration, Ole Koshal and I developed a list of life factors which was recited to participants to give them a sense of life components they could reflect upon. The list included: family (birth and current), marriage, children, health, educational attainment, tribal identification, location, dwelling, possessions, livestock holdings, shamba, land owned, daily workload, opportunities for employment, religious affiliation and/or church attendance. To conclude the interview, interviewees were asked first if livestock were a positive contributor to their wellbeing and to explain their answer, and secondly if livestock were a detractor from their wellbeing, and again to explain.

2.3.5 Livestock and Human Health Disease Prioritization, Rationalization and Causation

Disease prioritization interviews were initiated by asking the interviewee to freelist the livestock diseases that had the greatest impact on the community. Participants (n=124) were encouraged to list as many diseases as occurred to them, and after the initial listing, were prompted for any additional diseases that came to mind. When complete, the list was read back to the subject who was then asked to consider the complete list and choose the disease which affected the community the most. Upon selection, the respondent was asked why they had identified that disease (rationale for choice). The process was repeated with the remaining diseases until the full list was ordered. Each disease was then reviewed in turn and the interviewee asked: what caused it, what was the most effective treatment, and in what season it most commonly occurred. When livestock disease had been fully discussed the process was repeated for human diseases. I transcribed the initial disease list and order at the interview. Discussions of rationale, causation, treatment and seasonal associations were translated and transcribed after completion of all the interviews.

2.3.6 Self-Assessed Livestock Husbandry and Best Husbandry Practice Interviews

In order to better understand barriers to livestock productivity from the practitioner perspective, HoH and affiliated adults were asked to self-assess household performance of common livestock husbandry activities, herd characteristics and infrastructure (pens). The livestock duties list was used as the basis of the survey, with the omission of disease diagnosis, slaughtering and butchering, and assisting with births (because of the difficult of assessing these tasks), and the addition of pen quality (critical for livestock protection), vaccine delivery (because of the conversationally reported low prevalence), herd composition (balance of different types of livestock, because of the traditional Maasai preference for cattle) and cross-breed ownership (based on the frequently expressed desirability of such animals during the cross-sectional livestock health survey). Participants were asked to consider each activity/characteristic and self-rate the household on a scale of 1-3, where 1 was poor, 2 was average (kati-kati) and 3 was good (sidai).

Livestock husbandry was also explored via separate open-ended interviews in which HoH and affiliated adults were queried about the best approach for optimizing livestock productivity with regards to each of the tasks from the self-assessment. Each task or herd feature was introduced, and the respondent asked what they thought was the best method for maximizing productivity via that task or characteristic. After discussing each item on the list, participants were asked which activity was the most important overall for maximizing productivity, the best and worst performed by their specific household, and the rationale for their choices.

2.4 Sociodemographic and Quantitative Data Collection

2.4.1 Baseline Community Health Assessment and Sociodemographic Data

Cross-sectional baseline health and demographic data was collected from February-April, 2008 via a modified version of the Nomad Health in Chad questionnaire previously used for human-livestock health research on mobile pastoralists,[310] (Appendix A A Canadian nurse fluent in Swahili, assisted verbally by a Kenyan assistant fluent in Swahili and Maa, conducted physical and physiological measurements including height, middle upper arm circumference (MUAC), blood pressure, and heart rate, followed by a series of questions

about recent illness, treatment-seeking, preventative health practices, and potential zoonotic exposure routes ("General Health" onwards in the questionnaire). Ole Koshal and I, collected demographic and household information. 63% of community adults participated.

I carried out blood tests taking samples via a finger prick in a school classroom. A QBC Autoread Plus Hemotology Analyser (Drucker Diagnostics, USA) was used to measure hematocrit, hemoglobin, white blood cell counts, platelets, granulocytes (%), lymphocytes (%) and mean corpuscular hemoglobin concentration (MCHC). Due to widespread rumors and suspicions of unauthorized and surreptitious HIV testing by medical professionals in Kenya, only 45% of adult community residents (n=67) participated in blood tests.

All residents agreed to provide household demographic information. Village boundaries were set at the most distant homes on the north side of the community, and the geographic boundaries of the hills on the west, and the Sand River on the east and south. For the purpose of household data collection, adult status included: males or females of any age who were in or had been in a marital relationship; unmarried females of any age with children; or single males of any age, who lived separately from the main family home but within the family compound (there were no female equivalents of this category). HoH were designated as any adult with or without children who lived in their own compound, or adults who lived and ate independently within an extended family compound.

Sociodemographic information collected from participants at baseline in 2008 included: age (often estimated), tribal affiliation, time of arrival in Olkoroi, marital status (single, married, separated, abandoned, divorced, widowed), type of marriage (monogamous or polygamous), male age set (also applied to married women), male and female HoHs education attainment, number of children, education level of children, reasons for lack of education or prematurely terminated education (in adults and children), church attendance, sources of income, amount of family land, approximate proportion of family land under active cultivation, and preventative health practices (use of mosquito nets, treatment of milk, and source and treatment of household water supply). Additional household information was visually gathered for each household during home visits and daily encounters (type of house and roof, presence of a latrine, and vehicle, solar panel and/or cellphone ownership).

Sensitive information, such as physical abuse, alcohol consumption and brewing practice, was obtained indirectly throughout all field seasons (2008-2010) using a combination of longitudinal health self-reports, responses to the SWLS survey, direct observations, and informed residents.

2.4.2 Baseline Livestock Health Data

Baseline livestock health data and initial size of household livestock holdings were collected in the 2008 field season from Olkoroi and nearby communities of Laleta (east of Olkoroi), Ilkisaruni and Oltulele (south). Each household with livestock was visited, and data collected on numbers of cattle, sheep and goats, current livestock health, and any additional livestock health observations made by the owner when prompted at interview conclusion for perspectives on animal health.

2.4.3 Community Characteristics

Community-level attributes, such as the school, community stores, other businesses (such as a mill and small hair salon), hotels (small café/restaurants rather than lodging places), and churches, were visually identified. Class sizes and male: female ratios in each grade in 2008 were obtained from the head teacher at Olkoroi Primary. Kenya Certificate of Primary Education results from 2006-2009 were obtained from the Kenya Open Data government portal (http://icta.go.ke/open-data/). Informal observations were also made of teaching practice, presence/absence of government teachers and disciplinary interactions between teachers and students (which were sometimes public).

2.4.4 District Level Health Data

In April 2008, computer files of the 2007 monthly reports from all Narok District South clinics (including Olkoroi) were obtained from the Narok District Hospital. In 2009 I attempted to obtain 2008-2009 reports, but during division of the district into two administrative units (North and South), Narok South records had been lost.

2.4.5 Narok District Weather Data

Official weather records of daily highs, lows, hours of sunshine, and mm of rainfall for 2008-2010 were provided by the Narok weather office. Narok is approximately 50 km from Olkoroi in linear measurement, 3 hours travel time on rough roads, but weather patterns are similar enough to provide a general picture of climate variability.

2.4.6 Longitudinal Human and Livestock Health Data Collection

Self-reports on family and livestock health were collected biweekly from May 2008-November 2010. Interview were usually carried out at family homes between 7:00-11:00 am before household duties necessitated HoH departures. Livestock interviews were occasionally conducted in pasture. Residences were visited consecutively, over 3-4 days at the start of each two-week period. If HoHs were absent, return visits were made in the evening or the following day. Family health data was obtained preferentially from female HoH, and livestock data from male HoH, because of traditional responsibilities for children and animal holdings respectively. However, family data was occasionally reported by male HoH, and livestock interviewees included male and female HoH, hired shepherds, and older sons, daughters and in-laws. In most months (24 of 31), 2 visits were made to each family. Interviews were conducted in Maa, translated and transcribed into English concurrently during the visits. No diagnostic confirmations of disease self-reports were made.

Participation in human health interviews was universal but the community research assistant excluded families without livestock for the first year of data collection, therefore predictive human infectious disease models were built using May 2009-November 2010 data only. Data was collected from 75 distinct households between 2008 and 2010, but incomplete data sets resulted in exclusion of 23 households. Human health was tracked by individual household member. A total of 2820 household visits were used for model-building.

Participation in livestock health collection was also universal but more variable than household health because some households moved their livestock to and from Olkoroi, most typically in dry/drought seasons. The highest proportion of animals were moved in the May-November 2009 drought. When animals were moved, data collection continued only on any remaining livestock but resumed if/when livestock returned. Forty-seven livestock-owning

households participated in the study, and 2407 visits were made over the duration of the study. 1787 small ruminant and 1749 cattle morbidity/mortality reports were tabulated.

Most livestock could be directly attributed to one family unit, however extended families sometimes herded cattle or their small animals together (no families shared all livestock herding). A few single women with small holdings left their animals with extended family or neighbours, and some households kept part of their holdings in Olkoroi and part with relatives outside the community. Data was only collected on livestock present in Olkoroi, and for analytical purposes, animals were attributed to the primary herder. In families where adult sons lived with their parents, all livestock were attributed to the paternal head of the extended household except in one circumstance where an elderly father had disbursed his holdings. Due to capacity constraints, only biweekly livestock disease prevalence was monitored.

2.4.7 Young Livestock Growth Data

From May 2009 to November 2010, growth rates of up to three each of young goats, sheep and calves per livestock-owning household were followed using biweekly heart girth measurements. The study was started with selection of the youngest available animals of each type within the defined age parameters. Measurements began at birth when possible, and continued to six months for goats and sheep, and a year for calves. As animals aged out, they were replaced if new subjects were available. Loss to follow up of the measured animals was frequent via disease mortality, literal loss during grazing, predation, or transfer to other herds. Mortality rates were highest in the 2009 drought. As a result, measurement duration per animal varied substantially. Animals for which fewer than three measurements were obtained were not included in analysis.

All livestock owners were willing to participate in the growth study, but 14% were excluded because they had no young livestock (literally or not present in Olkoroi) over the study, or too few measurements were taken. Lack or insufficiency of measurements occurred due to a combination of: loss to follow up as detailed above; birth timing; a high rate of livestock abortions exacerbated by the drought in the first year of data collection; and movement of livestock (mostly in dry season/drought, but also according to family needs and

activities). Most measurements were taken on goats, followed by sheep and cattle (283, 151 and 103 distinct animals respectively) because poorer families usually had no or few cattle, goats were the cheapest and most common small ruminant, and the pregnancy rate of goats and sheep was much higher than cattle. In addition, the combination of a longer gestation period, and the high abortion and mortality rate of adult cattle during the drought meant almost no calves were born through 2009 and early 2010. Lastly, wealthier families (more likely to own cattle) moved their animals much more frequently during dry season/drought.

Calves were measured in 29 families. The number measured ranged from 1-7 per family, mean 3.5, standard deviation (SD) 4.9. Goats and/or sheep were measured in 37 families. Total small stock measured per family ranged from 3-28, mean 11.6, SD 5.8. Data was collected biweekly, alternating with livestock health, using fabric tape measures calibrated to weight via heart girth measurements. To measure heart girth, the tape measure is wrapped firmly just behind an animal's front legs and read between the shoulders. Each animal was measured twice per visit and the measurements averaged. At the first measurement of each animal, the age, sex and a detailed physical description was recorded to enable accurate follow up. Heart girth correlation with weight has been extensively validated in a wide variety of species, and a diversity of locations. It is typically used when scale availability is limited or is a low priority due to resource constraints.[311-313] Analysis was carried out on the weights corresponding to girth measurements.

2.5 Data Analysis

2.5.1 Wealth and Wellbeing

Frequency of household wealth markers with the addition of land ownership and HoH demographic characteristics, were tabulated and compared by sex using Pearson's chi-square tests. Markers with little community variation (90% + uniformity), such as clothing, home furnishing, utilities, medical, and veterinary practices were excluded from further analysis. Centroid-based cluster analysis of household wealth markers was used to economically differentiate households. Final variables included, based on focus group discussion and standards from the literature were: marriage type,[108] number of children,[108] initial herd size, type of livestock owned,[130, 229, 314] percentage change in herd size over the duration of

research, diversification[130, 314] categorized into 5 livelihood groups (none, traditional with no livestock, traditional including livestock, some non-traditional, and primarily non-traditional income), approximate size of landholdings and proportion under cultivation,[108] house type (traditional vs traditional and metal roof),[315] vehicle[314, 316] and cellphone ownership.[317, 318]

Tallies of SWLS response were grouped according to Diener interpretations.[319] Because of the small number of dissatisfied (4 men and 5 women) and very satisfied respondents (2 men and 4 women), for analytical purposes "dissatisfied" subjects were added to the "slightly dissatisfied", and the "very satisfied" to the "satisfied". Qualitative contributors and detractors from wellbeing were grouped into related categories (for example answers related to livestock ownership, or business activity). Proportional differences between men and women in SWLS categories and choice of qualitative contributors and detractors, were assessed using Pearson's chi-square tests.

Variables used to build an explanatory model for total SWLS were selected based on wealth and wellbeing literature (pastoral/Maasai focused), Olkoroi focus groups, self-identified contributors and detractors to wellbeing, community observations and/or longitudinal health reports (alcohol consumption and physical abuse). Variables used were: sex,[185, 239] age set[e] ranging from 1-7 (women are traditionally affiliated with their husband's age group),[185, 239] diversification (non-traditional livelihood practices vs traditional),[108, 314] marriage type (monogamous or polygamous vs unmarried), marital status (married vs any form of single HoH status, including never married, separated, abandoned, divorced, or widowed),[239] number of children,[108, 314] alcohol consumption (none vs any), domestic abuse (none vs observed or documented in data collection), church attendance (any vs none),[239] and log of tropical livestock units (TLU),[108, 229] land ownership (any vs none),[108, 314] and status as decision making HoH (yes or no).[320]

Correlation of the following variable pairs was anticipated and confirmed by chi-square analysis: sex and current marital status, sex and domestic abuse, sex and HoH, and HoH and control of livestock. In addition, church attendance was 100% correlated (100%)

[e] Most adults did not know their age accurately but identified with a known age sets. Age-set 1 was the oldest.

with teetotalism (abstention was required in local Christian churches). Correlated variables were included in the full models because of the exploratory nature of the investigation.

Analysis was carried out with SAS for Windows, 9.4. The SAS procedure GLM (generalized linear model) was used to explore the capacity of the variables to predict total wellbeing. All variables were evaluated first as univariate predictors then combined in a multivariate model without exclusion due to the exploratory nature of the investigation. Backwards elimination was used to identify the most parsimonious combination of variables to predict wellbeing, and results expressed as coefficients with 95% CI.

2.5.2 Livestock Duties and Relationship of Livestock to Wellbeing

The proportions of men and women who currently or had previously engaged in each livestock task were summarized by task. Tests for differences in livestock task responsibilities by sex were carried out using Pearson's chi-square analysis.

First answers to queries about the positive and negative influence of livestock on wellbeing were summarized and overall differences between men and women for positive influences were tested using Pearson's chi-square analysis. Sex differences for the proportion of men versus women who agreed with the statement, "Do livestock detract from wellbeing" were also tested using Pearson's chi-square but due to the small number of respondents who agreed, sex differences in specific negative attributions were not tested.

2.5.3 Livestock Disease Prioritizations and Cultural Competency

Prioritization data was interpreted with both quantitative and qualitative methodology. Quantitative ranking was determined by assigning each of the diseases a value corresponding to total frequency of identification. The most commonly mentioned disease was assigned a value of 20 (the total number of distinct diseases identified), the next most frequent, 19, down to the least mentioned which was valued as 1. The average of the respondent's unused ranks was assigned to the remaining diseases of the 20 that were not selected by each interviewee. The sum of the values derived from each respondent for each disease (prioritization score) was used to order the overall ranking. As the number of

respondents who selected diseases ranked 11-20 were low (seven or fewer, and six diseases identified by only one person), only the top ten ranked diseases were reported on.

Qualitative ranking was determined by weighted frequency which was subsequently used to calculate a livestock disease cultural competency (familiarity with a subject relative to other members of a group) rating for each respondent. Each disease was weighted by the proportion of respondents who had selected it. The total of weighted values for each individual was added to yield a domain familiarity or cultural competency.[321] Male vs female cultural competency for livestock disease was tested using a 2 sided t-test.

2.5.4 Herding Duties: Self-Assessment and Best Practice

Self-assessments of household herding tasks were tabulated by rating (1, 2, and 3, corresponding to excellent, average, and poor) and by sex. Chi-square analysis was used to compare the proportion of men vs women who selected each possible ranking for each task.

2.5.5 Herd size Models

Explanatory herd size (log TLU) models used only the characteristics of the primary decision maker for each household, the male or defacto head in partnered households, or the de jure[f] head of solo households. Variables included were sex (male vs female), age-set of male HoH (present or absent), diversification (non-traditional vs traditional), current relationship status (partnered vs non-partnered), number of children, alcohol consumption (none vs any), and church attendance (any vs no Christian church affiliation).

Analysis was carried out using SAS for Windows, 9.4. A generalized linear model (proc GLM) was used to predict log herd size. All variables were initially evaluated by univariate analysis then combined in a multivariate model without exclusion. Backwards elimination was used to identify the most parsimonious combination of explanatory variables ($p<0.05$), the parameters and 95% CI associated with each significant variable. Parameters

[f] Defacto FHH are households in which the male partner is effectively absent although the marriage is intact, while de jure FHH are ones in which a MHH is absent due to divorce or death.

and confidence intervals were back converted into TLU units via an inverse log transformation.

2.5.6 Young Livestock Growth Rate Model

Young animal growth rates per day were calculated for each young animal (n=501) using a linear regression model (SAS proc reg) and multiplied by 30 to generate a per month rate. Monthly rates were used as the dependent variable in a further regression to explore potential associations between growth rates and livestock, climate and owner-related variables. Before assembling the final model including climate, owner and livestock-related variables, a preliminary exploration of non-owner related variables was conducted using only climate (normal, drought or transition), animal type (sheep, goat or cow), animal sex, and age (in days). Animal sex was non-significant and was dropped from further modelling. Differences in sheep versus cattle growth rates were not significant, but all animal types were retained for the final model. The final model incorporated owner variables of sex, age, marital status, diversification, number of children, and church attendance, livestock variables of species, age, herd type, herd size (TLU), and the season variable.

Preliminary growth rate calculations and final model building was conducted using SAS for Windows, 9.4. The proc genmod statement with a normal distribution and link=identity statement (traditional linear regression) was used to identify variables associated with growth rates. The genmod procedure was chosen to account for within herd correlations using GEE (Generalized Estimating Equations) methodology. All variables were first evaluated by univariate analysis then combined in a multivariate model. Backwards elimination was used to identify the most parsimonious combination of explanatory variables, and to determine the parameters and 95% CI associated with each.

2.5.7 Human and Livestock Infectious Disease Frequency Models

Self-reported health data on both livestock and residents was collected twice a month, but for model-building, morbidities were averaged for the month. Models were constructed to explore possible associations of seasonal (normal/drought/transition), temporal (bimonthly periods), herd and household variables with total small ruminant and cattle disease burdens,

and the most commonly reported disease for each category of livestock (the locally identified small ruminant disease "olodua" and trypanosomiasis in cattle). A variable corresponding to the specific month (1-31 for the entire study duration) in which the data was collected was also included to ensure that family to family data were compared in appropriate time order but was not used as an explanatory variable. Livestock variables included herd type (goats and/or sheep, or cattle only vs both) and herd size (log TLU). Owner variables included: sex, age set of male HoH (or former male partner), diversification, current marital status, number of children, church attendance, herd size, and livestock movement (owner relocation of livestock during dry/drought periods).

Associations with self-reported human infectious disease incidence were explored using the same temporal and household variables as for livestock disease, but with the addition of total small ruminant and cattle disease prevalence for each time interval. Because the first year of data had to be discarded (encompassing half of the "normal" climate data), the remaining data was grouped into drought and post-drought seasonal categories only.

Analysis was carried out using SAS for Windows, 9.4. A generalized linear model was used to explain the average monthly prevalence/incidence of disease (for livestock, the total number of diseased livestock for the month or "events", divided by the product of herd size and number of reports i.e. "trials", for human diseases, the total number of newly reported diseases, divided by the product of total adults/children and number of reports collected), using a binomial distribution with link=logit. The genmod procedure was used because of the need to use GEE methods to adjust for multiple levels of correlation in the data (which proc logistic cannot do). The "repeated subject" statement was used to account for family level correlations within herds/family members, and the "within" statement was used to account for correlation between the months (1-31). The estimate statement was used to convert coefficients and confidence intervals into odds ratios.

All variables were initially evaluated by univariate analysis then combined in a multivariate model. Backwards elimination was used to identify the most parsimonious combination of explanatory variables, and the parameters and 95% CI associated with each variable.

Chapter 3: Researcher Positionality, Research and Community Context

3.1 Introduction

3.1.1 Objectives

The intent of this chapter is fourfold:

- to establish my positionality as regards the community and its members
- to discuss the relevance of a single community study to human and livestock health research in poor and under-served livestock dependent communities
- to provide context for data and analytical models presented in subsequent chapters on livestock health, and human health and wellbeing, using descriptive epidemiology to characterize the environment, demographics, culture, customs, and capital that both supported and constrained the health, livelihoods, wealth and wellbeing of Olkoroi residents.
- to demonstrate commonalities between Olkoroi and other rural Maasai communities, which have been reported upon in the human and livestock health and development literature focused on the Maasai.

3.1.2 "The Perspective and Position" of the Researcher

Qualitative research acknowledges "…analysis is inherently subjective because the researcher is the instrument for analysis…"[322] This perspective also applies to quantitative work, as suggested by philosophers such as Hume, Schmacher, Duhem and Quine, who contributed to the development of scientific realism,[323] underdetermination (uncertainty in epidemiology) and causal inference.[324-327] Nonetheless, tools such as bracketing and reflexive thinking,[328] used to facilitate honesty and transparency in decision making, are more commonly used in the qualitative arena. Consideration of positionality is increasingly viewed as necessary for epidemiologists whether quantitative or qualitative. It is particularly important given the problematic history of poverty oriented research into livestock,[16, 44] livestock keepers,[12, 74] and the Maasai specifically.[329-331]

My introduction to East Africa occurred via participation as a faculty member in the Langara College Canadian Field Studies in Africa (CFSIA) program for post-secondary students, over a cumulative four months, between 2001 and 2002. While with the program, I

visited schools, development and women's groups primarily in rural Kenya, but also Uganda. From 2002-2006, I was also a member of a CIDA-Association of Canadian Community Colleges (ACCC) development project in Mwanza, Tanzania. Although the work had no relation to Maasai concerns, I gained knowledge on Tanzanian history, government and health policies, which later facilitated comparison with Kenya. As part of the ACCC team I visited and interviewed community medical, legal, NGO and political representatives. In both projects I became simultaneously more interested in East Africa, and engaged with Maasai communities in particular, but increasingly uncomfortable with the dynamics of engagement between Canadian coordinators and students, East African partners and employees, and especially the disregard shown in the Tanzania project for CIDA protocols.

When I began my own research, I read qualitative texts (for example the Schensul and LeCompte series) during fieldwork preparation, kept research diaries, and wrote memos almost continuously while in Kenya, and during data analysis and writing in Canada. While motivated in part by recommended protocol, I also wrote almost instinctively to explore, alleviate, and manage tensions associated with individual, linguistic and cultural isolation in the field, as well as significant pressure I felt as a Canadian, educated, "enkashumpai" (female Caucasian) researcher working in a predominantly illiterate and poor community. Other aspects of my identity that affected my perspectives included single parenthood with full financial responsibility for my four children (who accompanied me for two of my three field seasons), and employment as a post-secondary educator. The latter were significant for several reasons. A high proportion of Olkoroi women were actual or de facto single parents who faced difficulty in providing for their children, and community access to education had been and continues to be limited. Village gossip described me as a millionaire. I regularly received requests for assistance and was sought after for answers to questions I could not always answer. Conversely, I was sometimes viewed as ignorant about livestock, generally treated patiently but sometimes laughed at when I made errors in custom and language, and resented on occasion when I could not meet the requests made of me.

I was personally motivated to do this research for several reasons. My family history features marginalization, illiteracy and poverty. My experience with the failure of the CIDA project to follow mandated gender protocols and authentic participatory activities, made me

want to engage in a different kind of research. Most importantly, after more than a decade of working on small-scale community development in Maasailand (primarily Olkoroi), and seeing the importance of livestock first-hand, I wanted to better understand the relationships between livestock and human health/wellbeing. My preliminary readings identified many claims of positive association, but little concrete evidence.

3.1.3 The Importance of Single Community Studies

> *Community studies are particularly relevant to the study of rural health and wellbeing because they identify the context of health behaviours and decisions, and extend the study of health to consider class, identity and other social determinants. Community studies expand the focus of health and wellbeing research to include the daily life of health consumers and the interacting issues facing many rural residents.*[332]

> *…the priorities, capacities and needs of local [livestock-dependent] populations and health systems in resource-poor contexts are neglected and sidelined…questioning some of the normative One Health assumptions and rhetoric…demands contextualized knowledge only possible by detailed analysis of particular cases….*[264]

Single community studies[333, 334] can help to bridge knowledge gaps and identify key differences within populations that may be obscured in larger studies.[332] They may be particularly useful for investigating complex health questions[333, 335] such as those posed in One Health or Ecohealth research.[g, 264] Single community investigations may also be useful in exploratory research where data is insufficient to confirm or reject claims, as is currently the case for many questions about the impact of livestock on the health and wellbeing of their keepers.[29] Although a single community study may not provide definitive answers, nor be generalizable across other communities,[337] it can help to guide future research.[264, 334, 338] Local perspective obtained directly from residents, is also necessary to ensure that

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[g] One Health and Ecohealth are overlapping models that attempt to situate human health within larger, interacting systems. Ecohealth differs from One Health in that it attempts to understand the relationships between human health and ecosystems, albeit using a much wider definition of ecosystem than is in the ecological traditional, and explicitly includes the use participatory methodologies, interdisciplinary cooperation, and consideration of socioeconomic influences. 336. Bunch MJ, Waltner-Toews D. Grappling with Complexity: the Context for One Health and the Ecohealth Approach. One Health: The Theory and Practice of Integrated Health Approaches2015. p. 415.

interventions by outside agencies meet community priorities.[339] Lastly, single "case" studies (wherein a case can range from an individual to a nation), in the form of process tracing, have been increasingly recognised as an effective way to understand the results of development interventions. Specifically, process tracing can support external validation by identifying case characteristics associated with varied intervention outcomes.[340, 341]

To ensure accuracy and validity in participatory development research, it is vital to identify and include the marginalized and vulnerable, obtain perspectives from all genders, and respect and incorporate local culture, knowledge and understanding.[342-345] Full community inclusion and ownership of interventions developed and implemented based on research findings are also critical for sustainability.[344, 346, 347] However, such necessary inclusions may be hindered by biases associated with rural poverty/global health investigations. Common biases include gender,[344] location (studies are likely to be conducted in more accessible communities, and regions),[26, 44] and sampling bias (absence of "hidden" or marginalized members of communities).[264, 348-354] In addition, it may be difficult to collect enough data or follow up long enough to fully capture the dynamics of values, priorities, relationships, activities and consequent livelihood choices made by residents, or long term intervention outcomes.[16, 44, 342, 355, 356] In pastoral research specifically, there tends to be less data or follow up from more isolated rural communities, drought climate cycles,[343] or highly mobile communities.[26, 342] The challenges of rural poverty research may in part explain why the failure rate of livestock-focused development has been unacceptably high.[16]

Worldwide, the number of livestock-dependent households is large and their histories and political position are diverse.[357] A further complication in understanding the relationship between livestock and human wellbeing/health is that customs, priorities, practices and outcomes differ between and within livestock-keeping cultures, and also in different circumstances.[342, 358] For example, morbidity, mortality and productivity of livestock may vary depending on household SES, local infrastructure, geography, and climate cycles. No single research or intervention approach can possibly be effective for every group. Nonetheless, types of vulnerabilities, causal pathways, confounders and barriers to the use of livestock for wealth, health and wellbeing enhancement can be identified through representative community studies. Although the complexity of livestock-human dynamics

likely preclude a single approach, cumulative knowledge from multiple community studies[334] could provide a set of templates with which to start research and evaluation, and ultimately interventions to support livestock-based livelihoods.[264]

Pastoral livestock keeping is somewhat unpredictable, and practice has evolved to manage uncertainty. [359] Ongoing, possibly more frequent droughts in ASAL regions, political shifts and processes such as land privatization[127] and industrial development in pastoral territory, have only increased uncertainty.[126, 343] It has been suggested that generalization may not be possible, in "….high uncertainty undertaking[s]".[341] Academic recognition of this difficulty has contributed to an increased interest in the application of realist study and evaluation in the health arena, and most recently in the development context. [341, 360, 361] Realistic evaluation evolved from scientific realism and acknowledges that interventions are implemented in social contexts. [362] Although the realist health literature focuses primarily on complex interventions, the principles also apply to research[361] and the enormous potential variability in magnitude and range of health-related variables. These elements can include abiotic and biotic factors, as well as the responses, interactions, and behaviours of both those under observation and the observers.[57] The realist approach accepts that any particular outcome is highly dependent on a host of interactions between variables that often change over time.[363] Realist investigations also recognize that research, interventions and evaluations often explicitly fail to follow up long enough to determine if collected information is representative of "real life" in the absence of outsider professionals.[337, 341] Ultimately the realistic approach seeks to determine "…what works for whom, when, where and why,"[332, 264] and community studies are an important part of answering this question.[341]

3.1.4 Olkoroi as a Representative Maasai Community

Past and current literature[108, 117, 123, 137, 139, 163, 229, 258, 330, 331, 364-374], the data obtained for this thesis, and the strong links between Olkoroi and settlements in Kenya and Tanzania (e.g. routine movement, exchange of material goods and livestock, and arranged marriages), suggest substantial commonalities between Olkoroi and other rural Maasai communities. While Kenya and Tanzania have very different geopolitical histories, original Maasai territory extended from Kenya deep into Tanzania.[1] In both nations, the Maasai lost and

continue to lose extensive territory, and were marginalized by colonial and post-colonial regimes.[1, 108, 127, 186, 330, 375, 376] Hodgson and others convincingly claim marginalization continues and may even be accelerating.[126, 127, 377] The Maasai migrated throughout both countries, but their roots remain in rural areas where culture, lifestyle, and livelihood, share more similarities across borders than with urban centres.[108, 377] In addition, despite repeated government interventions that have weakened traditional mechanisms of tribal cohesion, customary practices, for example male age sets (groups of age-affiliated males), and male and female circumcision, widely persist.[186, 378]

The Maasai have long diversified as necessary, but most continue to identify with pastoralism, and share a strong pride in tribal history, custom, and language.[186, 377, 379] Many communities struggle with the same challenges: preserving heritage, livelihood, and values, while incorporating new practices, and balancing family, age and gender roles, against individual needs.[380] Numerous studies by Maasai-focused academics such as Grandin, Coast, Hodgson, Galaty, Rigby, Holland, Waller, Talle, Spear, Spencer, and more recently Hughes, Homewood, Archambault, Mwangi, and Wangui, note extensive similarities between Maasai communities across East Africa. Pastoralism, by tradition a community-based livelihood, even in settled communities, values and promotes connections and tradition.

3.2 Setting: Physical Geography, Climate, Ecosystem

Olkoroi is bordered by the Sand River on the south and east, and forested hills on the west. The river ran dry during droughts, but impeded movement in the wet season. Livestock drowned in the river every rainy season and human deaths were occasionally reported upstream from of Olkoroi. The combination of savannah, forested hills, and natural water sources created prime habitat for disease vectors. Tsetse fly and ticks contributed significantly to livestock disease, and mosquitos caused a high incidence of malaria.

Figure 3-1 Olkoroi from the Western Hills

Olkoroi falls within the Greater Mara Ecosystem, which has a mean annual temperature of 16-18 degrees Celsius, highs around 25, and lows 8. Annual precipitation is normally between 840 and 1000 mm.[381] In Kenya, including Olkoroi, long rains usually fall from March-June and short rains, November-December. Residents perceived that rainfall variability had increased causing more frequent drought, as has been reported widely in the academic literature.[343, 382-385] Major droughts occurred in 2000, 2004, 2009, 2013, and 2016, and as an individual precipitator and amplifier of other routes of herd loss and resultant poverty, were a significant concern:

> *...if the serious drought occurs it may destroy our life.* (SWLS/livestock duties interview: 37-year-old male, 2009)

> *Drought…ever caused great loss to my family.* (SWLS/livestock duties interview: 65-year-old male, 2009)

There was a high prevalence of wild animals in the area, due to game reserve proximity and the nearby forested hills. Most residents did not hunt and pretended to an aversion, as per cultural narrative, for wild game, but ate it given opportunity. Wild herbivores such as savannah buffalo or waterbucks sometimes damaged crops, and occasionally destroyed entire plantings. They were also a potential source of livestock disease, for example, malignant catarrhal fever, or the zoonoses anthrax and brucellosis.[386, 387] Large, aggressive herbivores such as buffalo and elephants could be a physical threat, as were carnivores, which regularly attacked livestock and, although legally protected, were sometimes killed to stop repeated predation. To a lesser extent, animals such as monkeys, snakes, and foxes, also caused problems, including crop damage, livestock injury, and transmission of livestock pathogens.

3.3 Geopolitical Structure

The politician immediately responsible to Olkoroi was the Naikarra subdivision assistant chief who visited monthly to address matters such as land demarcation, conflicts, or illegal activities such as charcoal making or home brewing. Like most Maasai, Olkoroi residents supported the Orange Democratic Movement (ODM) nationally.

3.4 Community Structure

3.4.1 Origin, Ethnicity, Community and Family Structure

Olkoroi was a young community, first settled in 1979. Most families had arrived between 1980 and 1990, and all but three were Maasai. Two related families were Kalenjin, one Ogiek, and three wives were from the Kamba, Kikuyu and Samburu tribes. Section (independent, geographically delimited tribal sub-groups)[364] lineage was Ilpurko except for a Tanzanian and Kenyan from Ilarusa and Ildamat sections respectively. Below the section level, the strongest affiliations were traditional clans (descendants of common ancestors) and age sets.[365] Just as tribalism has been historically, nationally and detrimentally exploited,[388] clan connections were divisive locally during elections, and in ongoing land adjudication.

Traditionally, Maasai families lived in extended groupings centred on a male HoH and his wives. Women were married off in arranged marriages after circumcision to much

older (at least two age sets) men who had completed warrior service and graduated to junior elder status. Many rural Maasai still follow this pattern, although love and age peer marriages have become more common.[389, 390] A recent study carried out in neighbouring Kajiado county, observed, counter to East and SSA trends, a decrease in average Maasai marital age, possibly due to increasing insecurity and poverty. Importantly, age of female circumcision had declined by three years over the past four decades,[391] a trend which has potentially negative implications for age of marriage and female access to education.

The Maasai are customarily polygamous, but in Olkoroi, the practice may have been in decline. Of 150 adults, 60, from 28 families, had been or were in a polygamous marriage, similar to proportions reported by Coast in 2006,[392] but only 20 intact families were polygamous. A possible decrease in polygamy could have been due to a strong local Christian influence and cultural shifts, but community focus groups on wealth identified polygamy as a sign of prosperity, as also reported by McCabe et. al.[143] Only three of the poorest families were polygamous, and in all three either the husband or one or more of the wives had left, rendering it de facto single parent or monogamous. Some polygamous fathers had monogamous sons, but the converse was also seen, and it was not uncommon for men to be pressured by poor families to take young, additional wives from inside and/or outside the community. Despite traditional polygamy and a possible movement to increased monogamy, I was told that extra-marital relationships were historically and currently common, as reported by other researchers.[390] Such liaisons frequently produced children (to whom mothers sometimes disclosed the identity of their biological fathers).

Traditionally, Maasai women marry into their husband's family while sons stay, gradually take over family assets, and provide for aging parents. However, a traditional Maasai expression is "No son circumcised before his father" implying a son cannot make decisions for the extended family until his father dies. In the absence or death of a male HoH, wives maintained control of the family livestock until sons (or daughters, if there were no sons), married. Women who had left a marriage, were abandoned, or widowed, often but not always lived with extended family including parents, sons, or sons-in-law. Half of the Olkoroi households (38 of 75) present during this research lived in an extended arrangement (related but independent households who shared some herding duties, or independent and

dependent households living in close proximity) while 36 households were nuclear. Only one permanent resident lived alone: an older childless widower. Extended families took many forms. Several families hosted young, uneducated, unmarried sisters who helped adult sisters with household duties. Other forms included: single and/or married sons who shared family livestock duties but deferred decisions to their father; adult brothers and sometimes brothers-in-law (often including a widowed mother as these forms tended to evolve from sons living with independent parents); and widowed and dependent women, living with a married son and/or daughter(s)-in-law. There were also combinations of these patterns. The most common forms of extended settlements were independent or dependent widowed women living with adult sons or daughters-in-law (with children of their own), and adult sons, married or unmarried, living with their independent parents sharing herding responsibilities.

Community size varied minimally but regularly because of movement driven by two opposing reasons, as also described by Homewood and others.[108, 124, 368, 393-395] Customary pastoralism requires livestock movement for trading or grazing, while "modern" traditions require movement of children to boarding schools, and adults for business, jobs in tourist camps, or government work in education, healthcare, reserves, law enforcement or the military. The largest movements observed in Olkoroi were in the drought period of 2009.

Land subdivision beginning in 2010 and completed in early 2017, was ongoing throughout my research and write-up. The process had created conflict and excluded some long term residents. Communally held land is a key characteristic of traditional pastoralism, and within Maasai territory, borders historically existed primarily between sections. Negotiated inter-sectional resource use, especially during dry seasons and drought, however, was the norm,[118] but in the 1960's, the Kenyan government began mandated land privatization.[117] The process is still ongoing and has been very delayed in pastoral regions. The Olkoroi community recognised that private land ownership would have a substantial impact on grazing practice, necessitate movement for most families, and potentially cause loss of community cohesion. There was also a strong awareness that privatization would increase difficulties in accessing sufficient seasonal and drought pasture, upon which traditional pastoralism depends.

If land is divided then it really limit pastoralism. (23 year old male, 2014)

When the land is fully divided and every member issued with a title deed then nobody is allowed to graze on somebody else land/shamba. The land demarcation will affect the usual animal's migration during drought season. The people would have to look for relatives and friends land in case of natural calamities occurred. We don't usually borrow permission to live where you want to move your animals because the land is communal. Tanzania is still communal therefore people can move there but you have to ask permission from village elders and relatives if you have any. When the land is demarcated no areas should be left for animal's movement. (30 year old male, 2014)

However, as in other Maasai communities in both Kenya and Tanzania, Olkoroi residents had a long memory of historic land losses into the present. Although land privatization would not restore Maasai sovereignty over remaining territory,[1, 330, 396] residents perceived that land title would reduce "land grabbing"[8, 119], and was thus seen as a necessary evil.

Any land which is not yet demarcated or registered as an adjudicated section may be grab by some corrupt leaders as the country experienced frequently in past as well to nowadays. (30 year old male, 2014)

3.4.2 Housing: Structure and Cultural Practice

Almost all households lived in traditional Maasai houses built by the female HoH: low, wood-framed homes plastered with a mixture of mud and cow dung. Traditional homes required little or no cash outlay but deteriorated quickly and often leaked in the rainy season. Therefore, most women aspired to "modern" houses with stronger frames, plastered in more durable clay composites from the riverbanks, and roofed with iron sheets. Such houses typically had three-four rooms, each with a lockable door, did not leak, and were seen as a mark of achievement and wealth. Most households, 63/75, owned one house (or one per wife). 47/63 had a traditional home, while 16 had a "modern" house. Of the 12 families with two homes, most had a modern iron-sheet and a traditional house though two families had two modern houses and one had two traditional homes.

In traditional houses, families slept under the same roof until children were circumcised, when it became culturally inappropriate for them to sleep in the same house as opposite sex parents.[163] Women stated this custom created female vulnerability, as girls could not sleep at home, but were not always provided secure alternate space. Mothers reported that girls were consequently more likely to be involved in coercive sexual activity or to begin sexual relations with peers or older men in whose homes they found shelter. In turn, this increased risk of early pregnancy. Along with other advantages, iron-sheet houses with separate rooms, each with their own lockable door, allowed older girls to remain at home.

Men who built iron-sheet houses sometimes reserved them for their own use, but when women built such homes, typically with their personal, rather than family resources, they were shared with the entire household. Ironically, women who owned modern houses often continued to spend most of their time in a traditional home because they were easier to heat and repel mosquitoes. All new houses of any type were rapidly and heavily infested with biting insects including fleas, cockroaches and bedbugs. However, the low height, small windows and ventilation holes of traditional homes trapped heat and smoke from the fire more effectively, which deterred mosquitos, though not other pests.

A few wealthy families had solar panels and/or water-collection systems attached to their modern homes. Of the four families with solar panels, two HoH were employed by the local missionary and two had salaried jobs outside Olkoroi.

3.4.3 Community and Family Decision Making

Major family and community decisions in Olkoroi were usually made by men. For example, women were excluded from land adjudication in contravention of Kenyan law, a commonly reported East African phenomenon.[71, 397-402] A never-married woman ran the main village shop, served on the school committee, attended church regularly, had five children by local men and had lived in Olkoroi for more than 30 years. But, without a male HoH, she received no land, ostensibly because she was Kalenjin, although her Kalenjin uncle, also an Olkoroi resident, was allotted property, as were the male, Ogiek HoHs. When discussions were held about my research and potential livestock oriented interventions, a few female HoH attended but did not speak. The major exception was the school committee in which

both men and women participated. At the family level fathers tended to make education decisions for children although some families appeared to make joint schooling choices, also noted by Bachar in her exploration of Maasai attitudes towards female education in Kajiado, Kenya. Several women were also observed to circumvent male decisions by giving tacit or active support to daughters resistant to paternal discontinuation of their education.

Much academic and popular literature depicts Maasai society as patriarchal, but some argue that female avenues of power were first eroded by colonization, and further via breakdown of tradition.[393] Hodgson, a leader of academic opposition to the patriarchal narrative, asserts that historically each sex had major spheres of influence and women remain significant reservoirs and enactors of cultural and religious knowledge [330, 371, 376, 403]. This appeared true in Olkoroi as women played major roles in celebrations such as marriage and circumcision and regularly led prayers at public events. A few families were supported by educated daughters, which seemed to be contributing to a perceptual shift in possible gender roles, and a move away from viewing education for boys as a better investment (since by tradition, women become part of their husband's family but men remain with their birth family).[404, 405] Archambault, who has carried out extensive ethnographic research on education and gender in Elangata Wuas and Enkop, Kenyan Maasai communities northeast of Olkoroi,[70, 391, 393] has also documented increased support for female education.[391] Nonetheless, there was little support for women who acted against male authority or community norms, or women subjected to violence from their husbands, other males, or, in a case of community exclusion under physical threat, women. In addition, there was no censure of male violence against women; a young, pregnant woman was beaten until she hemorrhaged to death, but there was no consequence for her husband from any realm of authority. Residents of both sexes believed male HoHs were entitled to physically discipline children and female family members, even their mothers, a widely held belief across Kenya[406] and among the Maasai.[407] When one husband badly beat his wife, in public, another routinely abusive man took him aside at market and said, "You must not hit your wife with a stick, only your hands" (32-year-old male, 2012). Although the Kenyan government has legislated equality and protection for women and children,[391, 406] it was not enforced in Olkoroi. By tribal law, the only formal avenue for involvement with spousal conflict is

dispute resolution by parents of the couple. Since parents give and receive bride price, and technically have to be compensated in the case of marital breakdown, they are considered to have a stake in their children's marriages.[408]

3.5 Household Vulnerability

In Olkoroi 31/75 households were socioeconomically vulnerable, some in multiple dimensions. The three primary vulnerabilities were: single HoHs (24/75), livestock poverty (22/75 households had no livestock), routine neglect of female HoH and children (9/75) or violence against the female HoH (10/75). It was suggested by an informed witness, that there had been/were a few cases of violence or neglect by women towards men, but there were no self-reports of such. In combination, there were 34 distinct households with one or more significant vulnerabilities.

3.5.1 Single Heads of Household

Solo HoH led 24 of 75 households, all but four female, and 15 (63%) with dependent children. Half of the single HoH families were relatively secure[h] (Table 3-1). Seven owned their own livestock (independent security), and six had free access to the livestock of extended family (dependent security). The four independently secure households with children all had livestock but were anomalous in form: an unmarried son who supported his mother and her two grandchildren; a single mother by choice who ran a successful business; a widowed woman who looked after two grandchildren and had retained her husband's livestock; and a divorced woman with her own livestock (from earnings and gifts).

[h] As per the Alkire (2003) definition of human security: protection of "survival, livelihood, and dignity…[and]…a minimal subset of human development and human rights."

Table 3-1: Security of Olkoroi Single Heads of Household (2008-2010)

Single HoH	Secure		Insecure	Total (n=24)
	Independent	**Dependent**		
Dependent children	4 (16.7%)	5 (20.8%)	6 (25%)	**15 (62.5%)**
No dependent children	3 (12.5%)	1 (4.2%)	5 (20.8%)	**9 (37.5%)**
	7 (29.2%)	**6 (25%)**	**11 (45.8%)**	**24**

Abandonment (all but one household by the male HoH) and male death were the most common causes of solo households (Table 3-2). A few abandoned wives received some support from their husbands, but most abandoned families were neglected, or even abused (one wife was forbidden to educate her daughters, under threat of death). Five women had chosen to leave abusive (physically and/or psychologically) spouses. One man had been left by three wives because of his consistent neglect, and one was a widower. Three lone HoH were unmarried, one woman and two men.

Table 3-2: Reasons for Single Head of Household Status in Olkoroi, 2008-2010

HoH Sex	Abandoned	Widowed	Left/Abuse	Unmarried	Total
Female + dependent children)	**5**	4	**3**	1	**13 (65.4%)**
Female (no dependent children)	**2**	**3**	**2**	0	**7 (19.2%)**
Male (+ dependent children)	1	0	0	1	**2 (7.7%)**
Male (no dependent children)	0	1	0	1	**2 (7.7%)**
Total	**8 (33%)**	**8 (33%)**	**5 (21%)**	**3 (13%)**	**24**

A further eleven families were de facto single HoH because of frequent and/or prolonged absences/neglect by the male HoH. In these households, the husband controlled family assets, but the women had primary, if not complete responsibility, for the children.

My husband really hates me. He has abandoned me. (SWLS/livestock duties interview: 38-year-old woman, 2009)

You know that our husbands are dead [sic]. They don't even look for food. (Conversation during health data collection: 30-year-old woman, 2009)

Seven of the eleven de facto single HoH families (eight women, as two were from a polygamous family unit who cooperated for survival), struggled to provide for their children due to lack of family livestock, or inability to access family resources.

3.5.2 Livestock Poverty

Of 75 households, 22 had no livestock and a further 34 had less than four TLU per household member (insufficient to support the household by livestock alone).[i] Half of the households with no livestock had dependent children, most were single HoHs (17/22) of whom 14 were female. As tending livestock was the customary and most accessible livelihood, these households were amongst the poorest. None had secure alternate livelihoods. In combination with erosion of the cultural safety net,[108] limited job opportunities, and high employment insecurity, they were extremely vulnerable. Those without extended family support were most at-risk. Households with less than 4 TLU per household member were generally better off than households without livestock, as livestock were marketable assets, but families with small numbers of animals were still vulnerable. Such households typically lose proportionally more animals in disease outbreaks, droughts, and/or when unexpected costs arise.[17, 395, 410, 411] During and after data collection, more than 20% of Olkoroi households experienced major or full loss of animal holdings, due to one or more of: medical costs, drought and disease losses, failed marriages (requiring dowry return), abandonment, alcoholism, job loss, legal difficulties, and veterinary pharmaceutical errors. A few families were livestock poor because of past losses to raiding from which they had not

[i] It has been suggested that 4 tropical livestock units (TLU) per household member is a minimum number required for a livelihood dependent on livestock alone. 409. Toth R. Traps and thresholds in pastoralist mobility. American Journal of Agricultural Economics. 2015;97(1):315.

recovered. Raiding between communities/tribes was a Maasai norm in the past, though long illegal, and still occurred albeit at a reduced rate. Low frequencies of livestock theft, mostly small stock, was also prevalent within the community. Occasionally households experienced substantial losses to predators. Since livestock ownership customarily started with gifts from family,[376] family livestock poverty made it more difficult for new households to establish themselves and some families were livestock poor because of generational livestock poverty.

Women were more likely to be livestock-poor because of tribal rights of ownership. Traditionally, women received animals at life stages such as betrothal, marriage and childbirth.[412] These customs were in decline,[399, 412] and even so, women were expected to disperse their holdings to their sons at adulthood.[412, 413] Single, female HoH with young children were also constrained in their capacity to tend livestock or recover and build up livestock assets if lost. Consequently, if such women had animals, they were often left with extended family. Other reasons for no/low livestock holdings included events out of the owner's control, such as drought, disease, accidents, predators, and thefts/raiding. Four households suffered generational poverty, inheriting no livestock from their fathers.

3.5.3 Violence

Spousal violence was common, and obvious when it occurred outside the home (not unusual, as houses were small). The size of Olkoroi, proximity of homes, and cultural acceptance of corporal "punishment" for women, meant community awareness of abusive HoH was high. My field assistant, Ole Koshal, was trusted by local women who frequently came to him for assistance with conflict resolution, and we received information on violence through multiple additional routes: incidentally; as a direct witness (Ole Koshal) or via direct observation of injuries (both of us); from reports by victims, witnesses and infrequently from the clinic nurse; and victims regularly disclosed current and past experiences in the longitudinal health and SWLS studies. Consequently, while data on experience of domestic violence was not sought out via specific questions in any one study, I was able to obtain a comprehensive perspective on frequency, degree and repercussions of abuse.

Between 2008 and 2010, one woman died, two suffered miscarriages, and another required extended clinic care for head trauma due to spousal violence. No specific inquiries

were made as to the triggers for violence, but the following "infractions" were reported by victims as causes for some of the worst events: funds used to feed or obtain medical care for children without permission (4); alleged infidelity (1); maternal support for daughters to continue schooling (2); insufficient attention to livestock (1); and drinking (1). Because of the frequency and normalization of violence, households were only categorized as having violence vulnerability if it was regular or extreme. By this standard, ten households, with 11 women, were at risk. In five households, violence was the only vulnerability. The woman who died came from a household that was not materially poor.

> *Marriage. A terrible caning every time.* (SWLS/livestock duties interview: 24-year-old wife, 2009)

> *There is no man I can say has never abused his wife.* (Conversation: 28-year-old male, 2012)

In major conflict situations, women often left or were driven away to their birth family, but were frequently pressured to return to their spouses, especially if birth families were poor.

3.5.4 Alcohol and Vulnerability

Alcohol and consumption were not hidden. Alcohol was made (although brewing was illegal) and purchased in the village, and I regularly witnessed public drunkenness and outcomes thereof. Again, there was widespread community knowledge of drinking habits.

Alcohol frequently appeared to be part of vulnerability. In seven of 22 no-livestock households, livestock poverty was the result of alcoholism in the current male HoH, or in previous generations. We observed mothers from four households (two overlapping with the aforementioned seven, and two with lone female HoH) who periodically drank to the point of self and/or family harm (for example, drinking-related physical conflicts, childcare consigned to other women while mothers drank, or food insecurity due to alcohol expenditures). In two of the intact households with violence, abuse often occurred after drinking. Two abandoned households were visited by estranged husbands roughly once a year and regularly subjected

to drunken violence prior to departure. In addition, in the three, secure, de facto single headed households, alcohol had contributed to male HoH absence.

The interaction of alcohol with vulnerability was complex. Alcoholism had created generational poverty in one case (the current household was teetotal but had no assets), in a few had exacerbated poverty, but in others alcohol dependency seemed to have followed livestock loss and consequent poverty, compounding the challenge of recovery. In addition, some vulnerabilities were intertwined; in the four households where violence was accompanied by other vulnerabilities, three were neglected and asset-poor, and in one household with two wives and large livestock holdings, everyone but the husband was routinely hungry.

3.6 Children: Family size, child "ownership" and roles of children

The Maasai value children highly, and large households were rarely a concern except for anticipated education costs. Some polygamous families were very big (eight men had more than ten children), but the average number of children per HoH in 2010 was 4.8, a little higher than the national total fertility rate (TFR) which was 4.6 in 2008,[414] and is currently just under 4.[415] Because of polygamy, the average number of children per woman was lower than per man (4.4 vs 5.5). The range of family size for monogamous and polygamous women was between zero and eleven, the median for both was four, and means were very close (4.8 and 4.6 respectively). As monogamous men were the husbands of the aforementioned monogamous women, they too had a mean of 4.8 children. Family size for polygamous men, however, ranged from two to twenty, and the median and mean were ten and 10.3, respectively. Historically, reported fertility was lower in the Maasai compared to other tribes (about half peak historical national TFR), however there is little evidence to explain why.[163, 331, 416] Most residents viewed large families as desirable, expressed pride about family size, or regret about low fertility, but a few HoH[j] sought to limit family size, especially younger or educated HoH as also found in work with urban Maasai in Ngong.[316]

[j] A young wife asked me about birth control, as "Maasai women are like cows, we have a child each year whether we want to or not." Another spoke spontaneously of using the withdrawal method to avoid pregnancy.

Pastoralism and rural lack of infrastructure necessitate substantial physical work. High fertility can be a rational response to labour demand, poverty and/or high child mortality rates.[417] Although Olkoroi households were larger than the Kenyan average, higher rates of education had begun to create labour shortfalls in some homes, as referenced in other research.[108, 418, 419] In Olkoroi, this shortage was managed by: delayed school entry; denial of schooling for some children; and approximately half of livestock-owning families used uneducated children from extended family or from poorer families in Tanzania, which alleviated cost for the birth family and provided free/low cost labour for the recipients. In a few households, parents and older siblings took full responsibility and/or hired adult herders.

Maasai children taken into or borne within marriage, belong to their mother's husband.[379] Most Olkoroi FHH who were not widowed had custody of their children but if a husband decided to keep his wife's offspring after marital breakdown, he was supported by tribal law. An Olkoroi woman who lost her children to an abusive husband was denied help from the Narok Children's Office because she could not pay for staff travel costs to her husband's home: as was the norm for women who left a marriage, she had no assets or community support. Conversely, unmarried women had full responsibility for their children, even when the father was publicly known, also noted in Kajiado research.[391] While a few unmarried mothers lived with their parents, in Olkoroi most were quickly married off (based on observations of numerous schoolgirl pregnancies), sometimes to men who were not the biological fathers: both outcomes have also been reported by Archambault.[391] In the past, a pregnancy automatically ended female education, but in recent years, in Olkoroi, as elsewhere,[393, 404] grandmothers sometimes provided childcare to allow daughters to resume education. Regardless, few young Olkoroi women completed schooling after childbearing.

3.7 Education

Education was a double-edged sword for many in Olkoroi. As reported in the pastoral literature, educated children had greater earning and diversification potential, but sometimes at the cost of traditional skills and cultural literacy.[373, 393, 420] Time in school, for boarders especially, inevitably resulted in missed natural learning.[421] Negative perceptions about the effects of education included, as in other research: rejection or loss of culture,[422] immoral

behaviour,[373] and potential absence of adult children from the family.[70, 422] Education was viewed more positively than in the past and most families aspired to educating some children (as per SWLS/livestock duties interviews), but poverty and other barriers continued to limit access,[391, 423] many families had denied education to older children (male and female), and a few households still denied education to all female children. A recent report noted that 46% of Kenyan children out of school lived in ASAL[424] and in 2016, only 20% of Narok County secondary aged children were in school.[425] Education has also created new cultural pitfalls for young Maasai. Locally, male secondary graduates had trouble finding jobs, but sometimes rejected a return to herding, becoming "lost" between old and new culture, as observed both by Archambault in Kenya,[393] and Yao in Tanzania.[422] Olkoroi children often started school late, also noted in Tanzanian work,[426] and Olkoroi primary graduates could be in their late teens or older. Early marriage for girls remained common, so even if allowed school entry, they could be withdrawn before primary completion. Poor families could rarely afford high school, even if they supported education, and a daughter at home who could bring dowry, represented both economic burden and delayed financial opportunity:

> *…the main reason for sending my daughter for marriage is that I have no animals or resources to send her to high school…I love my daughter but unfortunately, I am poor and only the children are in my family, no cows. If she can get help [for school] ...I will not force her to get married. But if not then she should go to a husband's home.* (50-year-old father whose daughter has requested assistance to attend secondary school, 2010)

Education could protect girls from early marriage, through entry into an "ageless" state, [372, 373] as per Switzer, but most parents followed traditional marital age trajectories. Another cultural conundrum stemmed from observed occasional resistance of educated girls to traditionally arranged marriages, and some community members perceived schooled women as potentially difficult spouses, also referenced by Bachar.[373] Strong cultural aversion to birth control, reported by Coast in Tanzania,[163] and mentioned in conversation by several HoHs, resulted in regular schoolgirl pregnancies, in both primary and secondary students. One author has suggested pre-marital pregnancies have become more common, and some Maasai parents perceive an association increased pregnancy risks in unmarried girls and female education, but no data exists to confirm or disprove these claims.[391]

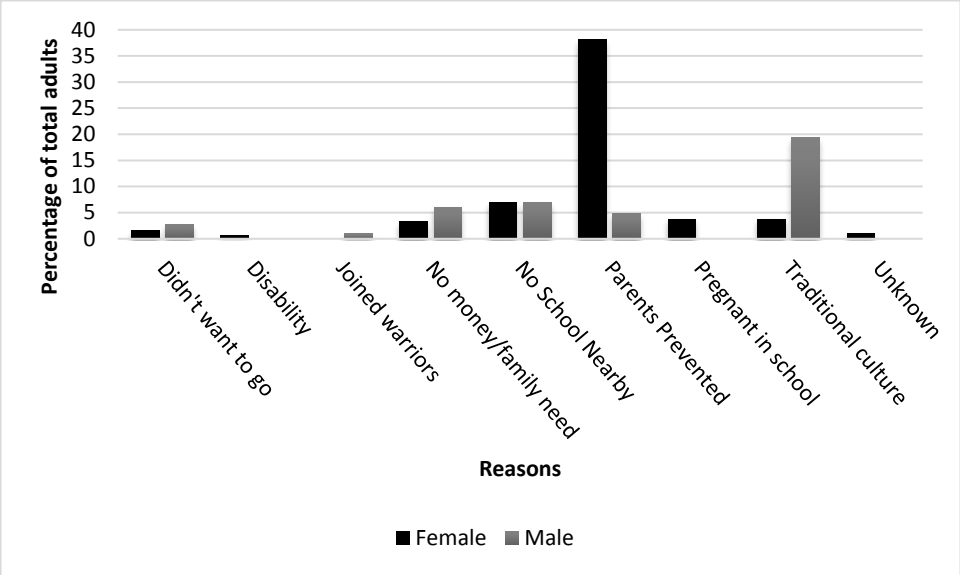
Historical Maasai opposition to formal education was driven in part by fear of cultural losses but also associated with betrayal by colonial "allies".[1, 393, 427] Past Maasai "position" vis a vis education was further exacerbated by lack of rural education resources[421] under colonial and post-colonial regimes, and may have been exaggerated to rationalize inadequate government support. Academic literature and personal discussions with older Maasai men in Olkoroi and other regions of Narok, iterated the theme of tribal educational intransigence, and referred to cultural marginalisation of early generations of educated boys (few girls attended in the past).[393] Conversely, some research suggests the Maasai have long supported education.[369, 391, 428, 429] A few Olkoroi fathers claimed that in the past, the least loved child was schooled to meet colonial demands of at least one educated child per family, while now they sent their "stupidest" children: the worst herders. The latter was a common narrative, and has been reported by others.[393, 419, 430] Rural Maasai remain educationally under-served for many reasons, and stereotype persists as regards their "opposition" to education. In encounters with educators in Olkoroi, the District Education Office, and in high schools attended by Olkoroi students, education officials, even those who were Maasai, regularly disparaged the "ignorance" of community parents and the Maasai in general.

3.8 Adult Education Attainment

Only 21.5% of adults had any education, mainly due to parental resistance for women, and traditional culture for men (Figure 3-2). In the past, schools were fewer, parental opposition stronger, and thus opportunity very limited.

> *...parents took education as a lost way of life. Girls were not allowed at all to access in any way education.* (SWLS/livestock duties interview: 58-year-old woman, 2009)

Figure 3-2: Reasons of Lack of/Interruption of Education in Olkoroi Adults (2008)



Of adults with education, roughly equal proportions of men and women had some schooling, but no adult women had completed secondary school (Table 3-3). A higher proportion of women than men had a full primary education, partly because the men who attended secondary had by default, completed primary. No Olkoroi HoH had attended post-secondary except two sponsored to theological college, the only option provided by the missionary, and only for men. The relative parity of adult education attainment was mostly due to the traditional two+ age set differences common between husband and wife. Married women, usually significantly younger than their spouses, were more likely to have had an opportunity to attend at least some school due to changing values and school availability, despite the ongoing lower likelihood of girls completing school and advancing to secondary.

Table 3-3: Olkoroi Adult Educational Attainment by Sex and Level of Education (2008)

Education Level							
Sex	**None**	**Some Prim.**	**Full Prim.**	**Some Sec.**	**Full. Sec.**	**Some Post-Sec.**	
Male	56 (78.9%)	8 (11.3%)	1 (1.4%)	1 (1.4%)	3 (4.3%)	2 (2.8%)	**71**
Female	85 (79.4%)	14 (13.1%)	5 (4.7%)	3 (2.8%)	0 (0.0%)	0 (0.0%)	**107**
Total	**141 (79.2%**	**22 (12.4%)**	**6 (3.4%**	**4 (2.2%)**	**3 (1.7%)**	**2 (1.1%)**	**178**

3.8.1 Current Attitudes and Barriers to Education

Although educationally better off than their parents, Olkoroi children still faced major obstacles due to poverty, custom, and gender. While lower grades sometimes had sex parity (Table 3-4), from 2006-2009 (there was no 2010 graduating class), the highest proportion of girls in grade eight was one third (Table 3-5). Most recently, in 2018, girls made up 15% of the grade eight class, indicating gender disparities continue. Family labour demands, gender roles, and poverty impeded both sexes, but gender disproportionately affected girls. They rarely spoke in class, or sought help from primarily male teachers (also noted by Bachar[373]), and did poorly on exams (Table 3-6). Archambault documented similar gendered behaviours and expectations, and suggested that formal education had been structured to reinforce traditional gender roles both nationally (based on textbooks) and in a Maasai specific sense in schools she observed, despite a shift away from pastoral livelihoods by educated Maasai.[393]

Table 3-4: Classroom sex ratios, Olkoroi Primary School, 2008

	Kind.	**Gr. 1**	**Gr. 2**	**Gr. 3**	**Grade 4**	**Gr. 5**	**Gr. 6**	**Gr. 7**	**Gr. 8**
Girls	17	10	3	8	7	6	6	3	4
Boys	28	13	12	15	12	7	10	8	8
Total	**45**	**23**	**15**	**23**	**19**	**13**	**16**	**11**	**10**

Some decline in progression through grade intervals was due to student transfer to better schools, but most missing children of both sexes, simply failed to complete. Furthermore, numbers alone do not fully capture the gendered nuances of educational

outcome. Of the four girls in 2008, the "best year", 2 became pregnant and dropped out before finishing, one married after finishing, and one progressed to secondary school but also became a pregnancy drop out. Conversely, boys able to access secondary school were much more likely to finish.

Table 3-5: Number of Boys and Girls Reaching Grade 8 at Olkoroi Primary School, 2006-2009

	2006	2007	2008	2009
Girls	3	0	4	1
Boys	9	7	8	7
Total	12	7	12	8

Competition in the Kenya Certificate of Primary Education (KCPE) national exam was very difficult for Olkoroi students. KCPE results determined secondary opportunities, but lack of resources, including teachers, resulted in high KCPE failure rates.

Table 3-6: Kenyan Certificate of Primary Education Results[k] for Olkoroi Primary School, 2006-2009

	2006			2007				2008			2009		
	301-350	251-300	< 250	351-400	301-350	251-300	< 250	301-350	251-300	< 250	301-350	251-300	< 250
Girls	0	2	1	0	0	0	0	0	0	4	0	1	3
Boys	2	6	1	1	1	3	2	2	3	3	1	2	5

3.9 Community Resources

3.9.1 Education: Olkoroi Primary School and Secondary Opportunity

A 7-room primary school served Olkoroi and surrounding villages. There were no local secondary schools and the least expensive boarding high schools cost $750-$1000/year.

[k] A pass (250/500) was viewed as a good result, marks over 300 excellent, and marks over 400, outstanding.

Better provincial or national schools, for which a few students qualified, were even more expensive, making secondary education beyond the reach of most families. Like many rural schools, Olkoroi Primary was understaffed. Government teachers were assigned yearly but were frequently absent and transferred quickly to positions closer to their families and urban centres. There was also a lack of books, equipment, classrooms, teacher offices and accommodation. Although free, Olkoroi Primary, like many schools, imposed fees to pay for extra teachers, non-teaching staff, equipment and/or field trips. Legally, children could not be denied schooling for financial reasons, but were routinely shamed if they did not have requested resources. In response, some children were kept home or resisted attendance.

3.9.2 Medical

Olkoroi had a community-built (1994) two-room clinic supported by the Christian Missionary Fellowship (CMF)[1]. CMF had provided seed money for supplies and salaries, built living quarters for on-site Maasai nurses, and coordinated operations. Ongoing costs were covered by fees-for-service. The clinic was one of eight run in Maasailand by CMF and served Olkoroi and surroundings. Basic health care was provided, but resources were limited, there were no dental nor laboratory services, and inpatient care was only available in extreme circumstances. Because staff had limited training, they sometimes misdiagnosed or underestimated the severity of illnesses and injuries and could not treat serious or complex problems. Treatment for HIV and tuberculosis, and mosquito nets for pregnant women and mothers of children under five, were free, funded by the government. Clinic fees were not expensive compared to urban, private or government clinics, but poorer families still often choose to go untreated or used traditional remedies. In addition, most women had to seek permission and/or funds from their husbands or extended family to attend the clinic.

The clinic stocked contraceptives, but women did not generally access birth control. Privacy was not always maintained, and some residents believed the clinic secretly tested for HIV. Nonetheless, most sought clinic treatment for serious or prolonged illnesses. The

[1] CMF is an evangelical, non-denominational missionary organisation that uses a variety of methodologies, including CHE, Community Health and Evangelism, to proselytize and create "dynamic Christ-centred communities that transform the world". (http://cmfi.org/ Accessed February 15th, 2014).

Maasai staff understood and respected certain cultural traditions, but they were literate, medically trained, mostly from larger communities, and CMF employees. Like teachers employed from outside, they occasionally exhibited condescending and/or judgemental attitudes. It was claimed, for example, "...alcoholism [in Olkoroi] leads to immoral behaviour. One cannot reason [with] or control this…. there is prostitution in Olkoroi- it is labelled friendship,"[431] although there was no evidence to support these suggestions. The clinic had some drawbacks and CMF exaggerated available service, but was important because of the reasonable fees, service in Ma, and proximity.

Residents also patronized the CMF Ewaso clinic in Narok, and private clinics in Ololaimutia and Narok. Ewaso functioned similarly to the Olkoroi clinic but had more services. Private clinics cost more than public or missionary clinics, but had shorter waits, and often offered more sophisticated services (for example ultrasounds). They were used as an intermediate between CMF clinics and hospital services, most commonly for unusual, more serious, or persistent illnesses unresolved by the Olkoroi clinic.

The most commonly used hospitals were the closest: Narok District, Waso, Tenwek (in Bomet), and AIC Kijabe. Narok District is a secular public hospital. Service quality was relatively poor and wait times long, but fees were lower, care more advanced than in clinics, and vaccinations and some maternity services were free. Waso Hospital, just over the Tanzanian border, was commonly attended for two main reasons, lower cost and better service. Tenwek a missionary hospital, significantly more distant than Narok, was believed to provide better service and charge less. AIC Kijabe, another religious hospital, was perceived to have the best service, had regular visits from international clinicians, provided some free treatment, and had staff who spoke Ma. However, only an hour from Nairobi, it was too difficult and expensive to access for most Olkoroi families. Kenyatta Hospital, in Nairobi, is the oldest, largest and premier Kenyan hospital, providing a wide variety of advanced services. However it sometimes has up to 300% bed occupancy.[432] Despite, and in part because of its stature, Kenyatta was rarely used by Olkoroi residents. It was far away, costly, and staff did not speak Ma. The few residents who travelled to Kenyatta stood out in their tribal dress among the almost universal adoption of western attire in Nairobi, and the

combination of economic, social, language, and knowledge barriers made Kenyatta almost impossible to access without help.

Traditional healers practiced in Olkoroi and surrounding communities. Residents used them due to easier access, lower costs, or if they preferred customary treatment.

3.10 Religion

Christians have proselytized in Maasailand for over 100 years[433] and a Ma speaking missionary has ministered in Olkoroi for more than 25 years. Historically, as with education, the Maasai significantly resisted Christianity,[433] and in Olkoroi there was some antipathy to the missionary based on perceptions of favouritism. The national education curriculum included religious education with primary emphasis on Christianity, and Christian affiliation appeared to be increasing. There were 3 Christian churches despite the small size of the community. Only 20% of residents attended church regularly but there was widespread belief in the Maasai God, Ngai, and all meetings, celebrations, and important life events began with a prayer. All the local churches followed strict gender roles, and opportunities for education, travel, and positions of authority went almost exclusively to men. Such opportunities sometimes brought financial remuneration, and a few affiliates had benefited significantly.

3.11 Livelihoods

Generally, all family members, with the exception of the very young and very old, contributed to household livelihood, even if disabled. Even very young children helped: to collect wood and water, cook, tend to infants, herd, or work the shamba. Elderly women performed similar tasks and also milked livestock, mended utensils and assisted in home building or repair. By tradition, men reduced their responsibilities as their sons reached adulthood, but in poor families continued to work even when elderly.

3.11.1 Traditional Pastoral Livelihood

Most households owned livestock, even when they had other revenue sources. If TLUs were sufficient, small ruminants were occasionally slaughtered for consumption, but cattle were typically only killed for ceremonial occasions. Women used cattle dung for house

mortar and hides to make ceremonial garments and bed coverings. Other needs such as food, clothing, school, cropping and veterinary expenses, were paid via livestock sales, usually goats, unless a large sum of money was needed. Animals were also used socially as gifts, and to support the community and extended family.

3.11.2 Cropping and Land Ownership

Only men held land, and like livestock, it was controlled by fathers until old age or death when it was distributed to sons, but not always equally. Only one woman controlled land, as a widow with no biological children. The first families to settle Olkoroi (from the 1970s to 1982) generally owned the largest land areas (approximately 35% of households). Those without land usually fell into one of two major categories, women or recent incomers. Women without land had typically returned to Olkoroi after leaving their husband/being widowed/abandoned elsewhere but could sometimes use the land of extended family. Similarly, widows were usually permitted by sons to use family land. Some single female HoH were unable to grow crops despite having land access, because of financial constraints. Most families (77%), grew food for home consumption, and just over a third of these also sold produce, mostly to supplement income a little. Six families sold the majority of their crops. Seventeen households grew no produce: seven of these families were vulnerable due to lack of assets, six were dependent on extended family for security with no assets of their own, and three did not crop because they were engaged in non-traditional livelihoods.

3.11.3 Small business

Many HoH of both sexes, had small businesses. Businesses varied by gender and rarely produced significant profit, especially women's endeavors, but could supplement family income. A third of the men made traditional weapons for sale. Women did not make weapons, but a few assembled quivers. Six adults ran stores in the village centre, selling staples such as soap, oil, and vegetables. These stores mostly purchased inventory locally or sold family produce, and therefore had very small profit margins, would come and go depending on family circumstance, and were vulnerable to periodic thefts. Three women ran small restaurants. The woman who ran the most successful store in the village had a primary

education and excelled because she made an effort to buy a greater diversity of merchandise, in larger quantities, at lower prices. When she had the opportunity, she also sold lucrative items such as petrol. There was usually one agroveterinary store, owned and staffed by men, in the village centre, which sold common veterinary medicines. This store was important as it sold small quantities of drugs to those who could not afford to buy entire containers.

A few men had recently begun to provide transportation services, either by truck (only one man, on salary for the missionary, who sold most of his livestock to purchase the vehicle) or by motorbike. Six men owned motorbikes by the end of the research period, but none had driver training and rarely used a helmet. A number of residents, drivers and passengers alike, had motorbike accidents due to any or all of lack of training, poor weather, and road quality. One family lost most of their livestock assets due to the combined expense of first a motorbike purchase followed by the medical costs of an accident.

The most common small business for women was production of beaded jewelry. Few were able to make much money due to its almost universal practice, but there was some demand as all residents wore traditional beaded adornment, and it was frequently given as gifts. Women sold their jewelry at weekly markets but Olkoroi itself was not a major thoroughfare, so they had little opportunity to profit from tourists. Many women also ran tiny home stores, particularly those with young children, who were most restricted in time and flexibility. As with jewelry making, there was little profit to be made.

Nineteen Olkoroi women brewed alcohol. Brewing was a profitable and relatively easy business for women with few other options and seemed more common in FHH (12 of the 19). Of the women who brewed, ten were drinkers. Brewing was of interest, due to the characteristics of the families where it occurred, and because it appeared to be a female-only activity. Of the 19 brewers, 14 came from vulnerable family units or were dependent on extended family. Twelve were impoverished and vulnerable due to poverty or death of their husbands/abandonment, while two were vulnerable to violence. However, there was a group of six related women (by marriage or blood) who brewed, in which only one was poor.

Because of wide-spread illiteracy, diversification was predominantly restricted to small business ventures. However, lack of capital, particularly for women, restricted potential substantively. Women also had to have permission from their husbands to pursue any kind of

business initiative. Even men rarely had major assets so initiating a more ambitious effort (such as the aforementioned transport activities) required liquidation of the only asset many had, livestock, or relying on local lenders who charged anywhere from 30-200% interest. Olkoroi, like many rural communities, was small, so unless a business was widely patronized (such as the corn mill or market transport) most commercial activities had limited growth capacity. Even the mill, because of the high initial outlay, was started by the missionary, and employed only a few church supporters. The poorest families were the least able to run a business as they lacked the capital for even the smallest purchase or investment.

3.11.4 Casual labour

Approximately 35 of 150 male and female adults were observed performing casual labour over the course of the investigation. Such work could be seasonal (for example shamba work), one-off tasks for other residents, or work for the missionary family when they were in residence. Most short-term work was crop or construction-related. Casual work was typically done by the poorest HoH, very low paid, and short duration. Sometimes heavy drinkers were paid in home-brew. Housework for the missionary's wife went only to women who attended church, although non-Christian men were occasionally hired for labour.

3.11.5 Salaried work

A small proportion of villagers worked on salary, primarily men. Four men herded for other families but herding pay was very low and there was frequent turnover. Three men were on salary from the missionary, and two at tourist camps. Camp jobs were insecure and often terminated in low season or if tourism was depressed (for example during 2008 post-election violence). Six men had worked for periods (i.e. not simultaneously) as community teachers, three as the school guard, and three women as school cook. School employees often quit in exasperation, as salaries were erratically paid via fees levied on school parents. Most salaried work was paid approximately $100 per month which was a good salary by local standards, and comparable to the national average.[434] Temporary salaried work was occasionally available through government initiatives such as voting, infrastructure installation, or public health interventions.

3.11.6 Professional Work

Low rates of literacy and opportunity in Olkoroi meant that few people worked in professional jobs. There were no fully qualified teachers, although a few residents had certificates in early childhood education. One individual had received nursing training through CMF, and eventually became a CMF administrator (but left the community to do so). Two male community members joined the army, and a third high school graduate was in the police force. The latter, however, was consistently posted away from home. Because of the size and resource limitations of Olkoroi, anyone who acquired professional training almost inevitably left the community in significant part because once hired, many public sector workers had to work wherever the government assigned them.

3.12 Conclusion: Constraints on Wealth, Wellbeing and Health

Residents of Olkoroi had the advantage of an atypical savannah location which permitted higher land productivity, but a variety of factors combined to make it difficult for community members to improve their SES, security, wellbeing and health. Some of the most critical barriers included: ongoing historical marginalization of the Maasai exacerbated by location; low literacy and limited access to education (any education in the past, and higher education currently), which not only restricted immediate opportunities for adults, but continued to constrain children and young adults, particularly those from the poorest families; failure of government infrastructure and laws to penetrate rural regions; and customary livelihoods and practice which, in combination with droughts, gender exclusion and lack of veterinary resources, provided limited capacity for advancement. Most of the challenges were magnified for women due to traditional gender roles and expectations. Some families were comfortably off, but seven of the 11 wealthiest and most secure families had achieved their positions through benefits received directly and indirectly from the local missionary, rather than traditional livelihood.

Chapter 4: Material vs Subjective Wellbeing in a Traditional Maasai Community: A Gendered Perspective

4.1 Introduction

The objectives of this chapter were threefold:

- to describe community identified wealth markers, compare the sociodemographic characteristics and material assets ownership of Olkoroi HoH by sex, and to determine which HoH characteristics, including TLU owned, were most useful in socioeconomic categorization of households
- to compare self-rated individual wellbeing (SWLS), as well as self-identified contributors to current and future wellbeing, by sex, and
- to construct an explanatory model of psychological wellbeing that could help better tailor and target interventions to support livestock keepers.

Effective poverty alleviation and enhancement of health and wellbeing in pastoralists requires an understanding of gender roles. However, gender is still inadequately incorporated into livestock-related research, despite recognition of its importance and routine integration into crop-based investigations.[74] Gender is important in the agricultural sector, and livestock-keeping specifically, not only because agriculture can be very effective in reducing the most extreme poverty,[435] most global poor live in rural communities,[291, 436] and women likely bear the higher poverty burden in most societies,[437] but also because: women perform 43% of agricultural labour in poor countries, 50% in SSA,[438] and may make up as much as 2/3 of poor livestock-keepers globally.[439, 440] In addition, estimates have suggested amelioration of gender-inequitable resource access could increase female agricultural output by 20-30%.[438]

Maasai men and women, like other pastoralists,[441-443] traditionally had overlapping roles in livestock keeping.[371, 376] Evidence suggests greater diversification has increased female workloads,[70, 350] and sometimes women's autonomy.[399] While both MHH and FHH may experience poverty, Maasai tribal custom makes livestock acquisition and retention especially challenging for women. By tribal law they do not inherit livestock, if widowed they hold family animals only until sons reach adulthood, and they do not receive a share of household assets if a marriage breaks down.[444] Furthermore, women often have difficulty

accessing resources and knowledge required to improve livestock productivity.[350, 440, 445, 446] Consequently, if FHH with limited livelihood options do not receive support from adult children or extended family, they fall easily into persistent poverty. Research indicates that such vulnerabilities are common in pastoral societies and pastoral women have been described as doubly marginalized by both livelihood and gender.[400, 445, 447]

In Kenya, a proportion of pastoralists are wealthy, and have successfully adjusted to modern financial, social and political frameworks, but many are poor with few prospects for advancement. Pastoral inequality is growing internationally[95, 108, 115, 221, 448-452], and even some pastoralists feel that traditional herding has become practically and economically less viable[108, 115, 314, 316, 449, 452-454]. Local and global socioeconomic changes, privatization and loss of land followed by shifts in herding practice, and greater external engagement via increased access to political, educational, and legal resources, are creating new opportunities for some pastoralists, but increased marginalization and exclusion for others.[17, 66, 115, 314, 449] Women may be particularly vulnerable to loss of traditional social and cultural safeguards,[455, 456] and yet are also using education[212] and the powers of national law to assert their rights in contradiction of customary law.[399] However, there have also been instances of the use of national law to deny pastoralists and especially women, customary shared resources.[350]

Many factors can contribute to vulnerability in the traditional Maasai, but based on observations in Olkoroi and a small amount of relevant research, women,[371, 457] the elderly,[350, 458] and single HoH[121] tend to be least secure. The latter two groups are also most likely to be female due to polygamy, marital age gaps and conventions of marriage dissolution. The most vulnerable pastoralists typically have the least access to the few available services and supports and in crisis, may be the first to lose access to these resources.[453] However, demographic information is sparse, and even DHS may not accurately represent Maasai households.[458]

There is a substantial amount of literature on pastoral and Maasai material wealth,[108, 229] but there is little information about psychological wellbeing (one older, 2005, SWLS survey and a more recent, 2018 Tanzanian conceptual wellbeing study)[185, 186]. Most research focuses on household wealth (typically livestock and land) and families with male and female HoH present. Rural populations are generally poorly documented,[315, 459] especially

pastoralists,[61, 95, 152, 156, 168] and pastoral women least of all.[61, 448, 460] There is little information, for example on pastoral FHH although they appear to be relatively common. The absence of necessary data to address pastoral challenges[73, 461, 462] and support efforts to escape marginalization is ironic: "Pastoralists are one of the most researched, yet least understood groups in the world."[461] The Maasai are probably the most researched of the pastoralists[73, 331, 463] yet major knowledge gaps remain, and key "facts" are often based on small bodies of data which may not be sound.[331, 342, 458]

Until recently, agricultural data from the developing world, particularly economic analyses, were often outdated, and like poverty data usually documented at the household level.[438] Despite some improvement, it remains common for current publications to cite figures from pastoral research conducted a decade or more earlier.[440] In addition, gendered aspects of agriculture were rarely adequately captured or even considered, and sometimes the contributions of women were excluded altogether.[464, 465]

> *…the gender and rural development literature demonstrates the existence of a broad, pervasive (if not universal), and enduring lack of women's inclusion in agricultural decision-making in households at scales and settings from the household to agricultural development programs and projects.*[466]

Gender mainstreaming has been an official development expectation since the late 1990's,[467] but is not always incorporated effectively, and frequently added as a project overlay rather than from inception.[438] Some agricultural development projects have even exacerbated gender inequities.[376, 468] A study of 35 years of gender mainstreaming in agricultural aid projects targeting vulnerable populations, determined that only 5.1% of 5834 projects included women or gender in project titles and descriptions, and furthermore that proportional funding allocated to women had declined since initiation of mainstreaming.[465] A 2019 gap analysis of pastoral sustainability found only 1.3% of 2658 publications on pastoralism included gender as a keyword[61] and concluded:

> *…little is known about pastoralist societies and the interlinkages between their practices and the rangelands on which these depend…*

Pastoral women may bring very different knowledge, skills and priorities to agriculture, for example a focus on security of food over yield.[445, 469] In addition, despite

unequal access to productive assets, pastoral women can still be found leading agricultural innovations.[470] Gender is particularly important in livestock-keeping and understanding both the roots of, and routes away from poverty, because animals may be accessible to women when it is difficult for them to purchase other kinds of material investments, and/or assert claim to family resources.[74] Although pastoral women usually own fewer livestock than men, their livestock frequently make up a greater proportion of their assets.[445]

Another challenge in development has been the visualization of wellbeing. Material poverty is an important influence on overall wellbeing, but other factors are also critical especially once basic needs are met.[471, 472] The necessity of including psychological measures of wellbeing in development has been relatively recently recognized,[332, 473, 474] but project incorporation has lagged behind,[475] especially in very poor communities, where basic survival concerns may seem most immediate. Furthermore, while there are clear connections between material wealth and base life satisfaction, when household wealth is controlled primarily by male HoH, family income may not adequately capture or predict the individual wellbeing of members unable to access resources due to position, gender, or both.[74, 314, 452, 465, 476, 477] Those who have little access to family assets, are also less able to obtain collateral-dependent services such as credit and insurance (which are often already difficult for pastoralists to obtain[314, 453]) to facilitate increased productivity and wealth.[466, 476, 478-480]

Women typically allocate spending differently than men, investing more in the household and children. As a consequence, it has been proposed that increased female income benefits children more than increased family income.[455, 476, 481, 482] Although it is widely held that single-parent are poorer than dual-parent households, and FHH are both the poorest and most common form of low income family,[437, 483-485] the empirical evidence supporting these claims is neither strong, nor consistent inter-nation, though there are countries where FHH are poorer on average.[484, 486] Furthermore, common negative outcomes for FHH, are frequently driven by non-monetary factors such as: gender roles, constraints, and discrimination;[437, 466, 484] family structure,[483, 487] though family processes (interactions) are thought to be more important;[488] specific structure of FHH;[483, 487] and/or are common in all wealth strata rather than concentrated at the lowest levels.[437]

There is little East African research on FHH, or on monogamous versus polygamous families.[476] Available information indicated major variation in socioeconomic status (SES) and household structure associations across Africa. South African (SA) and SSA data suggested that FHH could be better off, even with reduced financial security, due to conflict reduction, and greater investment in children.[484, 489-491] In West Africa, the poorest families were polygamous, but in East Africa and SA, they were FHH,[492] though a Ugandan study concluded the opposite.[487] A Zimbabwean study of the Shona found differences in FHH versus MHH, but noted that conclusions varied depending on whether comparisons were made of income versus assets, and types of FHH, de facto or de jure.[493] A review of data from 10 countries in the Global South, found that FHH were disproportionately asset poor in Ghana and Bangladesh, slightly more likely to be poor in general, but in real numbers most poor women lived in MHH.[486] Income allocation research and a small body of related findings on risk behavior and credit access, suggest that agricultural development targeted at the family level which does not consider gendered household resource investment may be inefficient.[466, 476] Lending support to these conclusions are studies which suggest families are more productive with the same resources if women have better access to available assets.[476]

No literature describing Maasai single HoH was found but a study on the related Samburu noted the frequency of FHH with children was increasing, such households usually lived with parents or brothers, and were denied asset inheritance.[452] Globally, the poorest FHH often live with extended family and may therefore be "hidden" from poverty assessment.[458, 485] In Kenya, despite national land laws protecting gender equity, women tend to be excluded from land ownership.[494] From 2013 and 2017 women received only 10% of registered land titles, and just 1.6% of actual land.[495] Most traditionally married Maasai women cannot use family assets independently nor participate in decision making on land and livestock.[314, 452, 496]

In the absence of data on FHH in traditional Maasai communities, I suggest that impoverished FHH's may be increasing because of two opposing forces: the custom of large age gaps at marriage and polygamy, and rejection of tradition by both younger men and women. The lack and/or inaccessibility of government services which might protect vulnerable FHH [453] likely exacerbates these drivers. Other contributing factors could include:

strongly gendered livelihoods, exclusion of women from land and livestock ownership, ongoing changes in asset usage resulting from monetarized economies,[371, 376] limited avenues of opportunity (such as access to credit and language barriers[476]), and the forces which cause women to become solo heads (spousal abuse, conflict, neglect and abandonment) which are also likely to magnify the other factors. As in the Samburu example, even when rural women are supported by extended family and avoid impoverishment, their opportunity to establish financial independence or develop an asset base is limited.

4.2 Results

4.2.1 Wealth Marker Focus Groups

Male and female characterizations for each wealth marker were very similar, therefore information from both groups was combined and summarized. Only characteristics which exhibited distinguishable variation were included in data summaries, and cluster analysis. Health was not included as it is generally considered to be an outcome of sociodemographic factors. Variable wealth markers as described and categorized by the focus groups are summarized in Table 4-1.

Table 4-1: Community Focus Groups' Delineation of Wealth Categories by Marker

Marker	Poor	Coping/Moderate	Wealthy
Livestock holdings	0-5 total, may not have cattle	6-20 livestock total	100's of livestock[m]
Source of income	Traditional livelihood	Similar to poor but training may expand potential.	Livestock and/or education. Live-stock are capital.
Food security	May go hungry. Little or no milk and/or meat.	More milk and food. Do not go hungry.	As much meat and milk as is desired.
House type	Traditional house	Metal roof, mud floor.	Cement walls and metal roof.

[m] Focus group descriptions left a large gap between the high end for moderate wealth and low end for wealthy (also noted by Yanda et al., 2010). One absentee owner owned ~1000 animals, however, a man in a nearby community had 6 wives and 1000's of animals and may have been the model used by interviewees.

Marker	Poor	Coping/Moderate	Wealthy
Vehicle ownership	None	Bicycle	More paid rides (no cars/trucks).
Polygamy/Number of Wives	Poverty prevents polygamy (0-1)	1-3 wives (monogamous by choice)	6+ wives
Education of children	None, or primary school only.	Can choose to send children to high school.	Can send children to post-secondary.

4.2.2 Sociodemographic Survey

Table 4-2 contains the results of the sociodemographic survey, tested by Chi-square analysis for sex differences. Men and women differed significantly for: marriage type, current marital status, domestic abuse experience, livelihood diversification, and cellphone ownership. Differences approached significance for alcohol consumption. Half of married adults were in/had been in a monogamous marriage, but polygamy resulted in a higher proportion of monogamous males relative to females. Almost two-thirds of women suffered/had suffered some marital abuse. Due to traditional age gaps at marriage, older community members were almost twice as likely to be male as female. Just over a fifth of the community received some type of support (employment, subsidized training, or direct assistance) from the local missionary.

Table 4-2: Baseline Community Characteristics of Study Population: Adult Members of Olkoroi Village, Narok District South, Kenya, 2008 (n=150)

Individual Socio-demographic Characteristics	**Male** n=59 (39.33%)	**Female** n=91 (61.66%)	**Total** n=150	**p value (Pearson's Chi- square test) for Sex Difference**
Any Education	20 (34%)	20 (22%)	40 (27%)	0.107
Marriage type, ever (monogamous)	**34 (66%)**	**47 (52%)**	**77 (51%)**	**0.002**
Current status (married)	**48 (81%)**	**60 (66%)**	**128 (85%)**	**0.040**
Age (older than 40)	31 (53%)	36 (24%)	67 (45%)	0.118
Alcohol consumption (none)	36 (61%)	68 (75%)	104 (69%)	0.075

Individual Socio-demographic Characteristics	**Male** n=59 (39.33%)	**Female** n=91 (61.66%)	**Total** n=150	**p value (Pearson's Chi- square test) for Sex Difference**
Domestic abuse experienced (none)	**59 (100%)**	**33 (36%)**	**92 (61%)**	**<0.0001**
Family size (>4 children)	31 (53%)	44 (48%)	75 (50%)	0.616
High-input Livelihood Diversification	**23 (39%)**	**8 (9%)**	**31 (21%)**	**<0.0001**
Cellphone Ownership	**20 (34%)**	**14 (15%)**	**34 (23%)**	**0.0082**
Church Attendance	9 (15%)	19 (21%)	28 (19%)	0.388
Missionary Assistance	11 (19%)	22 (24%)	33 (22%)	0.424

Table 4-3 summarizes household assets, and education status of community children. Chi-square tests evaluated potential differences associated with sex of the primary HoH.

Table 4-3: Household assets, and education status of community children in Olkoroi (2008)

HoH Material Assets	**Male HoH** n=47	**Female HoH** n=28	**Total** n=75	**p value**
Livestock owned at start of research (yes)	**42 (56%)**	**11 (14.7%)**	**53 (70.7%)**	**<0.0001**
TLU mean (standard deviation, s.d.)	19.5 (18.4)	16.7 (10.9)	18.9 (17.2)	
Vehicle ownership (yes)	**14 (30%)**	**1 (4%)**	**15 (20%)**	**0.006**
Land owned (yes)	**43 (91%)**	**13 (46%)**	**56 (75%)**	**<0.0001**
House type (Traditional and metal roof)	15 (32%)	8 (29%)	23 (31%)	0.7613
Mean proportion of children with some schooling	78.3%	77.4%	77.9%	
Children with household funded secondary education (of 326 potential students)	8 (2.5%)	9 (2.8%)	17 (5.2%)	

Male-headed households (MHH) versus FHH differed significantly in major asset ownership, with the exception of house type. Although the proportion of MHH who owed

livestock was more than twice that of FHH, average TLU was only slightly higher for MHH. Overall community variation in livestock holdings was large, with a range from 3.1-78.4 units. Few vehicles were owned, mostly bicycles (12), and all but one owned by men as women were culturally restricted from vehicle use except as passengers. Motorized vehicles were rare (at the beginning of the research, only three men who worked for the missionary had motorbikes). Customarily, only men owned land and female ownership was primarily de facto (albeit still beneficial as it allowed supplementation of family diet and also increased income potential). Very few families independently sent their children for secondary education. Of the children who had/were attending secondary school, seven (of 17) were from the three households where the male HoH held a salaried positions with the missionary.

Four TLU per household member is thought to be the minimum required to avoid persistent poverty.[409] A breakdown of livestock ownership by household structure, Table 4-4, shows only 25.3% of Olkoroi families, 16 MHH and three FHH, had enough livestock to survive by traditional livestock rearing alone, and almost a third of the households had none.

Table 4-4: Livestock Owned Relative to Poverty Threshold, Sex of Head of Household and Family Structure in Olkoroi

Livestock ownership	Monogamous	Polygamous	Single Heads of Household		Totals
			Female Headed Households	Male Headed Households	
No livestock	3	1	15	3	**22 (29.3%)**
Under threshold	21	11	2	0	**34 (45.3%)**
Above threshold	10	6	3	0	**19 (25.3%)**
Total	**34**	**18**	**20**	**3**	**75**

4.2.3 Cluster Analysis of Wealth Markers

Cluster analysis of wealth markers produced two major household groups based on livestock ownership (not quantity) only. One cluster consisted of 19 families (25%) without livestock, another of 53 (71%) households which owned some livestock, and there were three unique, single household clusters (4%). Each of the latter had a HoH with an unusual

combinations of wealth characteristics but no livestock: a separated, salaried, female teacher with children and no assets; an unmarried, male, secondary graduate with a salaried job at the local corn mill; and a FHH who lived independently of her polygamous husband but had not completely severed ties (with a metal-roof house, a small shamba, and educated children, she lived a comfortable, relatively autonomous life).

4.2.4 Psychological Wellbeing Interviews

The range of total wellbeing was 10-31, with a combined mean of 22.7 (the maximum score on the SWLW is 35) and an SD of 4.4. Calculated on a per question basis (dividing the total by 5), the mean was 4.5 per question (maximum self-rating for each question is seven), halfway between neutral and slightly agree, and a SD. of 0.88 per question. Mean wellbeing was 22.3 for women and 22.8 for men, and a similar proportion of men and women self-scored as dissatisfied/slightly dissatisfied. The differences in the proportions of men and women who felt an average level of life satisfaction versus satisfied/very satisfied, however, resulted in a statistically significant chi square test (p= 0.019) for sex differences (Table 4-5). When couples of discordant satisfactions were compared, women were the less satisfied in 26 of the 33 discordant marriage (27 marriages were satisfaction concordant).

Table 4-5: Relative Proportions of Men vs Women by Specific Wellbeing Category in Olkoroi (2009)[n]

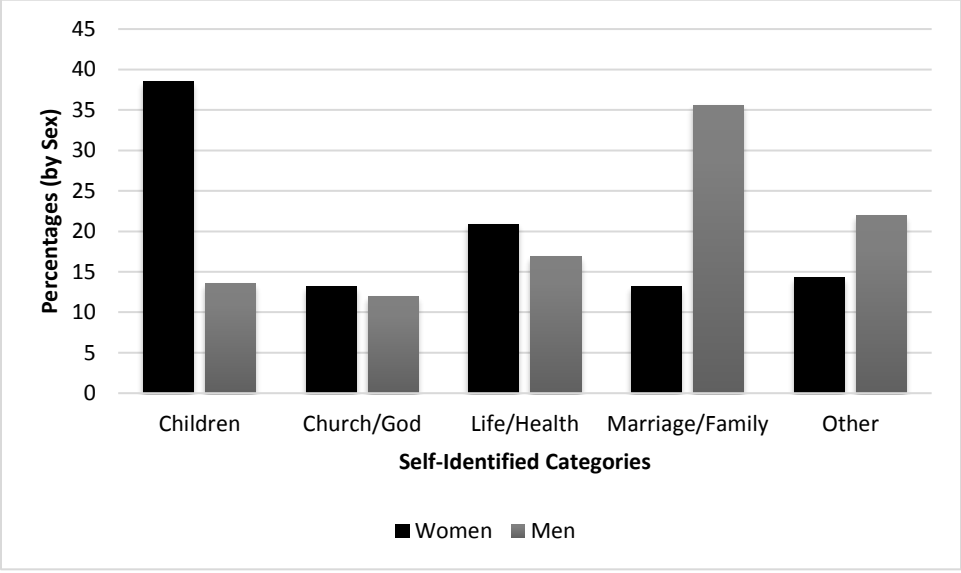
Sex	Dissatisfied/Slightly Dissatisfied	Average	Satisfied/V. Satisfied	Total
Men	12 (20.3%)	**15 (25.4%)**	**32 (54.2%)**	59
Women	19 (20.9%)	**42 (46.2%)**	**30 (33.0%)**	91
Total	31 (20.7%)	57 (38.0%)	62 (41.3%)	150

[n] In Diener's *Understanding Scores on the Satisfaction with Life Scale*, a total score of: 30-35 indicates high life satisfaction whereby life is not perfect but as good as can realistically be expected; scores of 25-29 represent people who are satisfied even if some spheres of their lives are problematic; 20-24 suggests average satisfaction but may indicates a desire for improvement; scores of 15-19 represent slightly below average satisfaction which can represent either several areas of small but significant dissatisfaction, or one area of major dissatisfaction; and people who score below 15 are substantial dissatisfied, with multiple dimensions of life functioning poorly, or a few going very badly. As only a small number of respondents scored in the dissatisfied (9) and very satisfied range (6), the former was included with the "slightly dissatisfied", and the latter with the "satisfied".

4.2.5 Contributors and Detractors to Wellbeing: Men vs Women

Men and women were statistically different ($p < 0.05$) in their attribution of most important current contributor to life satisfaction (Figure 4-1). The biggest differences were children (the choice of 38.5% of women but only 13.6% of men) and marriage/family (13.6% of women, and 35.6% of men). Men gave "other" responses (fewer than five respondents) at a higher rate (24%) than women (13.2%). The importance of this difference was unclear due to the variety and small overall contribution of each of the responses within "other", which included business, education, livestock, myself, nothing, and respect. "Myself" was the most common "other" response (9 respondents). One woman chose respect as the most important contributor to her wellbeing. Her choice became a latterly important representation of the most extreme gender effects on wellbeing when she died after a beating from her husband.

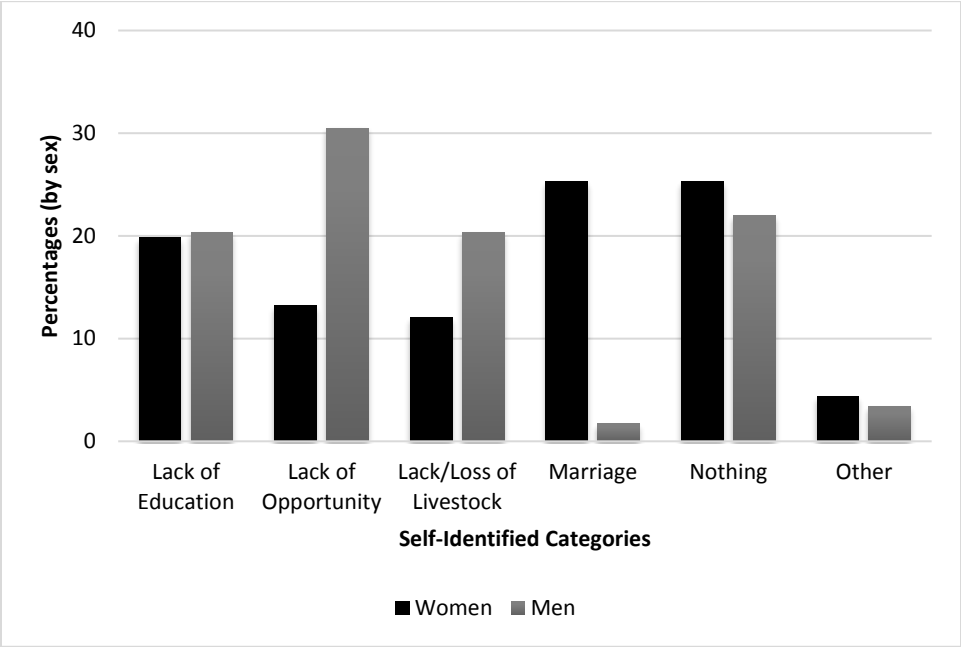
Figure 4-1: Most Important Contributor to Current Wellbeing in Olkoroi (2009): Women vs Men (n=150, p=0.025)



Men and women also chose different detractors from current wellbeing (Figure 4-2). They felt similarly about lack of education (19.8% of women, 20.3% of men), but more men identified lack of opportunity or resources (13.2% of women and 30.5% of men) and lack/loss of livestock (12.1 % of women versus 20.3% of men). The most striking difference was in the proportions who felt negatively about marriage. One man said marriage reduced

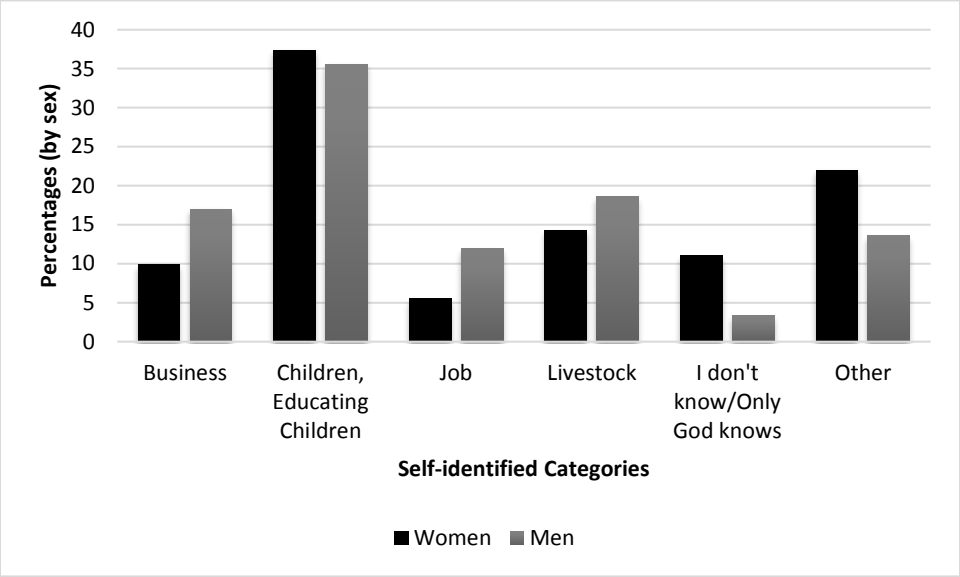
his wellbeing, in contrast to 25.3% of women. A quarter of both sexes felt there were no detractors in their life. Responses were more definite about wellbeing detractors than contributors as "other" answers made up only 4.7% of the total, and were mainly women. "Other" responses included health, thieves, children, don't know, and partner's death.

Figure 4-2: Most Important Detractors from Current Wellbeing in Olkoroi (2009): Women vs Men (n=150, p=0.0036)



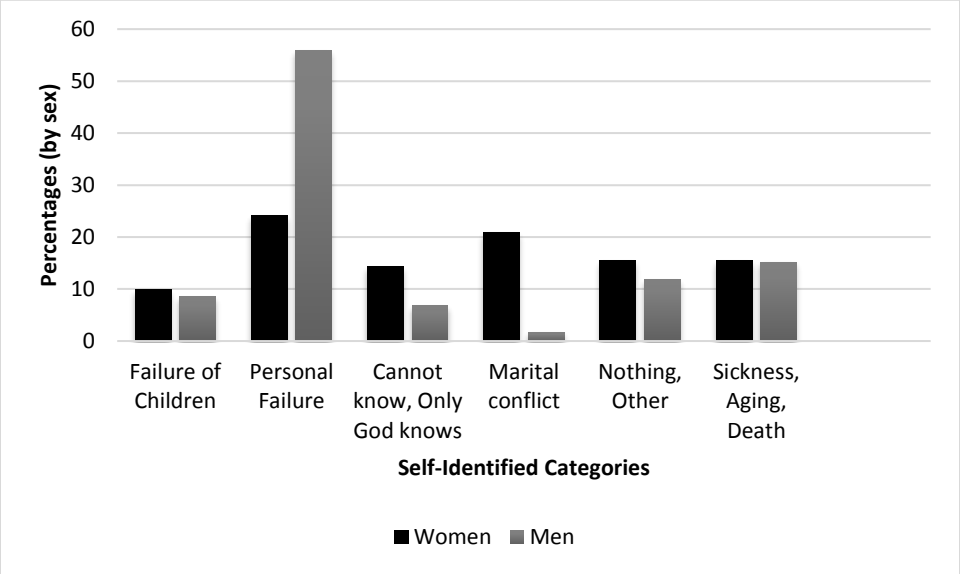
Male and female perspectives on future contributors to wellbeing did not differ significantly (Figure 4-3), although more men had hope for livelihood contributors such as business, salaried jobs or livestock (47.5% of men versus 29.7% of women). The most frequent response, children, was similar in in men (35.6%) and women (37.4%), as were feelings about education of children. Many respondents spontaneously elaborated that the potential of children to contribute to future parental wellbeing would depend on education attainment. Again, more female responses fell into the "other" category, 22.0%, versus 13.6% of men. "Other" response included myself/hard work, church, independence, opportunity, and health/long life.

Figure 4-3: Most Important Future Contributors to Wellbeing in Olkoroi (2009): Women vs Men (n=150, p=0.18)



Men and women were again different in choice of future wellbeing detractors (Figure 4-4). Men were much more concerned about loss of family assets/poverty (55.9% versus 24.2%) while women were worried about marital or family conflict harming future satisfaction (20.9% of women but no men). Women were less certain about what might disrupt their future, with 14.3% saying it was impossible to know, but only 6.8% of men. "Other" responses (14 women and seven men) included 9 responses of "nothing" (the most common), leaving church, unemployment, addiction, children's costs, and vulnerability.

Figure 4-4: Most Important Future Detractor from Wellbeing in Olkoroi (2009): Women vs Men (n=150, p=0.005)



4.2.6 Exploratory Wellbeing Model

In univariate analysis (Table 4-6) higher life satisfaction was associated with being: a non-drinker, a churchgoer, a landowner, married, and having more children and livestock. Position as primary household decision maker was close to significant (p=0.0599). In the full multivariate model, only increased livestock holdings and having more children predicted higher life satisfaction. Variables associated with higher life satisfaction in the final adjusted model were being a non-drinker, the household decision maker, and having more children and livestock.

Table 4-6: Unadjusted and Adjusted Linear Regression Coefficients and 95% Confidence Intervals of Variables Associated with Individual Life Satisfaction (n=150)

Characteristic	**Unadjusted Model** [95% C.I.]	**Adjusted Full Model** [95% CI]	**Adjusted Final Model** [95% CI]
Age set [1=oldest]	0.049 [-0.38, 0.47]	0.12 [-0.46, 0.70]	
Alcohol consumption [No]	**1.60 [0.078, 3.12]**	1.03 [-0.57, 2.62]	**1.50 [0.14, 2.86]**
Church Attendance [Yes]	**3.10 [1.35, 4.86]**	0.45 [-1.49, 2.40]	
Diversification [Non-trad.]	**2.02 [0.29, 3.75]**	0.39 [-1.43, 2.21]	
Current status [Married]	**2.67 [1.22, 5.87]**	0.25 [-1.85, 2.35]	
HoH Decision maker [Yes]	1.26 [-0.14, 2.67]	1.47 [-.062, 3.00]	**1.61 [0.39, 2.83]**
Education [Any]	-0.039 [-1.65, 1.57]	-0.38 [-2.05, 1.28]	
Land ownership [Yes]	**2.95 [0.91, 5.00]**	0.38 [-1.65, 2.41]	
Marriage type			
[Monogamous] **[Polygamous]**	2.47 [-0.64, 5.46] 1.99 [-1.11, 5.10]	0.83 [-2.98, 4.61] -0.25 [-4.29, 3.79]	
Number of children	**0.37 [0.18, 0.57]**	**0.32 [0.084, 0.55]**	**0.28 [0.10, 0.47]**
Log_{10} TLU owned	**3.23 [2.29, 4.18]**	**2.91 [1.71, 4.11]**	**2.95 [2.00, 3.91]**
Physical abuse [None]	1.30 [-0.13, 2.74]	1.01 [-0.48, 2.68]	
Sex [Male]	0.88 [-0.57, 2.33]	-1.25 [-3.12, 0.63]	

4.3 Discussion

4.3.1 Economic Differentiation of Olkoroi Families

> *In a Maasai society, if you have a lot of livestock, they will consider you as a rich man* (SWLS/livestock duties interview: 45 year old, monogamous man).

Two distinct household groups could be characterized by livestock ownership alone (any versus none). Inclusion of a variety of other wealth measures had little effect on cluster formation. This outcome was likely due to a number of factors. Most important was the

traditional livelihood and culture of Olkoroi residents, in which livestock remained central. Although some customs were changing (most children at least started primary school, for example) traditional Maasai values were the norm regardless of parental education, livelihood diversification or livestock holdings. Relatively uniform lifestyle and livelihood meant non-livestock wealth markers were either too uncommon or too widespread to be useful in differentiating wealth. Nonetheless, non-livestock markers identified by focus groups and later, in wellbeing discussions, provided insight into community aspirations.

Also relevant was Olkoroi's rural location which made resources, both human and material, difficult to access, and also, through relative isolation, supported maintenance of tradition and tribal law. Lastly, there was little local opportunity for non-traditional work except for a small number of salaried positions with the missionary (three men), other religious organisations, or at Olkoroi Primary. On occasion there was also temporary tourism, research, or government work. Most of these opportunities were exclusively for men except for low paid housework, available when the missionary was in residence.

Households with no livestock included some of the poorest Olkoroi residents. Only two HoH from this group had salaried employment, a FHH who worked as a kindergarten teacher (paid by the district council) and an unmarried man who ran the corn mill (hired by the missionary). The most accessible longer-term work for this group, albeit only for males, was herding, which, though poorly paid, was traditionally part of the pastoral safety net. Herders are occasionally rewarded with gifted livestock potentially providing an opportunity to build animal holdings and move up in socioeconomic standing. [314] Other types of work opportunities for those without livestock were also poorly paid, typically short-term and intermittent, but did not have the potential benefit of "earning" animals. Since families without livestock often lived hand to mouth, any earnings tended to be used for immediate survival needs such as food. In one FHH, two young sons were denied (free) elementary education and sent to work as salaried herders outside Olkoroi. Many families delayed schooling so children of both sexes could herd for their family, or educationally excluded at least one child completely. Child income was unlikely to shift individual or family status as remuneration was lower than that paid to adults, passed directly to the parent, and resulted in

no asset accrual for the young workers. A small observed subset of temporary employees were alcoholics who sometimes worked to earn money for, or were even paid in alcohol.

The poorest households frequently depended on extended family and/or sometimes other community members for assistance. This group though, did include a number of widowed women and daughters (7 of 22) who lead their own households, did not own any livestock, but were free to take milk as needed, from the herds of sons, sons-in-law, or parents. While these women and any dependent children were not destitute or chronically hungry, simultaneously they had few assets to facilitate independence or improve their circumstances, and frequently faced difficulty in obtaining funds for anything beyond basic needs of food and shelter (for example school fees). Loss of access to the resources of their family, would have left them in difficult circumstances. Other types of family or community support included space upon which to build a home, occasional food assistance, child care, or monetary aid (for example to pay school fees). Of families with livestock, only 35.8% of owners, or 25.3% of all households were above the threshold required to maintain herds through drought and disease outbreaks, and support the household via livestock alone.[409] As a consequence, most livestock owners needed to earn additional income.

Differentiated wealth markers in Olkoroi, were very similar to those recorded in participatory wealth ranking conducted in three mixed pastoral/agricultural and Maasai communities in Tanzania,[314] and Kenyan research done in predominantly Maasai Kisaju, in Kajiado County, albeit much more urban and diversified than Olkoroi in gender roles and livelihood options.[316] Specific commonalities included the Kisaju choice of livestock ownership, number of wives, food security, business activity, and vehicle ownership, as important wealth markers, although the specific quantities which corresponded to differing levels of wealth (three categories, as used in Olkoroi) varied between the communities. Similar to Olkoroi perceptions, two of the Kisaju respondents stated:

> *A rich man is one with money, land and livestock, family and many children. He has built plots of land and owns a vehicle* (RM 8, senior moran).

> *A rich man is one with large herds of livestock and a large family, for example one with five wives and a car* (RM 18, a 20 year old cattle trader and with no education).

Younger, more educated Kisaju respondents espoused similar criteria, but, unlike older participants and most Olkoroi respondents, were more likely to prioritize small families and monogamous relationships.[316] In Olkoroi, monogamy was promoted by Christian churches but linked to poverty by the focus groups. Big families, the tradition in Maasai culture, were viewed almost universally positively, as remains generally true in rural Africa.[458] Nonetheless, when discussing negative contributors to future wellbeing, a number of Olkoroi HoH, both male and female, commented on the difficulty of providing for large families, particularly if education was a family aspiration. Work by Switzer, Archambault and others suggest education is now widely prioritized in the Maasai, including opportunities for girls.[212, 393] In casual conversations, younger and/or educated Olkoroi residents occasionally articulated values similar to those of the younger Kisaju respondents, for example, referencing the use of birth control to control family size.

While the focus groups were asked to describe characteristics/behaviours/options associated with each wealth level for the list of wealth markers, participants frequently followed up by noting that most or all community members followed traditional practice. For a number of markers, education was as, if not more likely than wealth, to be the factor determining non-traditional practice.

> *All members of the community live in similar houses, the traditional Maasai housing made of sticks/logs and mud/dung…97% of parents of all categories have no education… All families use 4-legged stools no matter what level of wealth they possess… Most families also use traditional beds… almost everybody wears shukas [traditional fabric] though a few educated people may dress in a Western style…*
> (Responses from the men's wealth marker focus group, 2008)

Some poverty research on pastoral communities has suggested that cash revenue, and proximity, access and integration into market economies, often held up as key indicators of wealth or opportunity, are not good measurement tools or predictors of pastoral security and wealth.[66, 108] Educational attainment or possessions such as radios, used for SES demarcation in other SSA research, may likewise provide little differentiation in communities like Olkoroi, with low literacy rates. Focus group participants explicitly articulated that radios were not wealth indicators because they held little value for uneducated adults who could not speak English or Swahili (the official languages typically used in broadcasts), and

furthermore could not be used while herding. Women were almost universally illiterate in both national languages, but most men spoke at least some Swahili.

Livestock holdings have long been used as a wealth marker in pastoral research,[229] and remain a simple, effective way to quickly categorize families. However, regardless of marker(s) used, most studies have been able to differentiate more than two wealth strata.[108] It is possible that cluster analysis only identified two groups in Olkoroi as a consequence of investigating a single community, the relatively small number of households (75) and the high proportion of households without livestock. However, despite using substantially more complex models in their large, multi-team investigation of livelihoods in a range of Maasai communities in Kenya and Tanzania, the Homewood research groups found enormous variation in correlations between livelihoods and family revenue and concluded that livestock not only remained central to Maasai wellbeing, but additionally were the most common resource used to fund major diversification in all income strata.[108] The wealthiest household associated with Olkoroi (an order of magnitude more livestock than any other family) was not included in analyses because the HoH was absent (but had left his livestock in Olkoroi under the care of extended family), and furthermore liquidated his holdings shortly after data collection began. Like a small number of included HoH who attempted significant diversification efforts over the period of the research, the richest man purposefully used his animals to fund a major new business initiative. Most Olkoroi families, however, owned too few, if any, animals to support major diversification. As widely reported in pastoral research, smaller-scale diversification was generally used for herd maintenance and development.

4.3.2 Wellbeing

4.3.2.1 Male vs Female SWLS Scores

Similar overall proportions of Olkoroi adults self-rated as average/neutral in life satisfaction, to those who were satisfied/very satisfied, but women were significantly more likely to report average life satisfaction than men, who were conversely more likely to be satisfied/very satisfied. Sex differences in life satisfaction are not consistent globally, and neither are the explanatory conclusions of wellbeing researchers. Overall, unlike the findings in Olkoroi, international research suggests a trend to higher wellbeing in women compared to

men with some country and regional exceptions.[239, 497-499] The female positive wellbeing gap appears to be strongest in wealthy countries[471, 499] though some work concludes an almost universal no difference or female positive sex difference.[500] In contrast, some publications have noted a decline in female wellbeing in industrialized nations since the 1970's[501, 502] to the point that at least one study concluded men were now globally happier than women.[501] The 2015 World Happiness Report found women were slightly happier than men globally, but sex-based differences were small compared to age and regional differences.

Although Kenya is ranked as a lower-middle income country, and is no longer on the CIDA priority list of countries in greatest need, Tanzania remains poor.[503] Global happiness assessments carried out by Gallup reported very low Tanzanian scores, on average, compared to Kenya,[504] but regardless of national statistics, there is little to distinguish the status of rural Maasai in the two countries. As noted in chapter three, there was significant reciprocal movement between the two countries by residents of Olkoroi and surrounding communities. Even if relative East African national economic positions were relevant to gender differences in wellbeing, national trends may not be relevant to communities like Olkoroi. Gallup has also specifically acknowledged a "paucity of data on African happiness".[504]

Vieira-Lima[497] used World Values Survey (WVS) data to conclude that the biggest female positive gaps were in less industrialized nations with relatively low gender equality, though also remarked the reverse was true in a number of Latin American and European nations (without identifying any clear explanation for, or commonalities between "exception" countries). Of note in the Vieira-Lima publication was the finding that of the 5 countries with the highest wellbeing gap in favour of women, two were in East Africa and a third in southeast Africa (Uganda, Tanzania and Zimbabwe respectively). In contrast, some literature has claimed that a female-positive wellbeing gap did not extend to SSA[498, 499] and the 2017 World Happiness report called Africa "the unhappiest continent".[504] Graham et al.[499] found that countries with greater gender inequality exhibited lower female wellbeing, and available data from SSA showed higher male than female wellbeing in most years. The Graham research also noted an association between increased education and age with higher female wellbeing and concluded the generally global positive "marriage effect" did not hold true in rural areas or in the poorest nations, particularly the SSA and LAC regions. Although these

findings seem initially relevant to Olkoroi, further work by Graham suggested the negative marriage effect was driven by lower levels of satisfaction in married men in all national income strata, which contradicts the Olkoroi findings.[499] Nonetheless, the general conclusions of Graham may be relevant to Olkoroi and other pastoral communities where education rates are low, men control family resources and women cannot inherit critical survival assets, nor receive a share of household resources when marriages break down. More recent work by Meisenberg,[502] also using WVS data from 95 countries found that women had greater life satisfaction in approximately half of the surveyed countries, and men in the other half, although differences were not great (statistically significant differences were only found in 33 countries overall). In the ten African countries included, women were more satisfied than men.[502] Tanzania, though not Kenya, was included in the WVS.

The only other known SWLS study in a Maasai community recorded very high life satisfaction (98% of the sample, n=127, self-rated above average, with a mean score of 5.4), and concluded that women were significantly more satisfied than men.[185] However, there were some possible biases in this investigation. The researchers appeared to have spent a short time in the community and in our experience the wellbeing concept required extensive discussion to put into a Maasai context. The Maasai frequently present a proud, albeit clichéd vision of traditional life to non-Maasai and the Biswas-Diener research described Maasai customs in a superficial and outdated manner, typical of the generic narrative presented to outsiders at first interaction.[505] Furthermore the Biswas-Diener work referred to interviewing participants in villages, suggesting in doing so, they had avoided selection bias. However, when the term "village" is used by the Maasai, it is not usually used in the Western sense. Instead it refers to a group of connected families, at minimum bound by friendship and allied agendas, and frequently by blood or marriage, for example a group of brothers/brothers-in-law and their families. Although it is not clear where the Diener research took place, a related publication implied it may have been in the same geographical area as my work.[506]

There are a number of possible explanations for my findings of proportionally different life satisfaction in Olkoroi women versus men as well as lower life satisfaction than previously reported in the Maasai. The first is the well documented global association of income with subjective wellbeing which is strongest in poorest countries.[239, 471, 499, 507]

Income is also more important when evaluating life holistically, as in my study, as opposed to contemplating specific life compartments.[499] In Olkoroi, only 3/28 adults (11%) from households without livestock self-rated above average life satisfaction, in contrast with 59/122 (48%) adults affiliated with livestock-owning families. Many of the no livestock families were structurally vulnerable as well. Twenty-one of the 28 adults in the no-livestock households had no partner: 7 were widowed, 12 had been abandoned or had left an abusive spouse, and 2 were unmarried, younger men. Furthermore, 17/21 of the unpartnered adults were women, and 13/22 of the no livestock households were FHH. As well as the negative female gender-wellbeing associations in poor countries identified in Gallup poll data[499], analysis of Gallup data by others concluded that social support was an important component of wellbeing.[508] Olkoroi families without livestock were also much more likely to be missing social safety nets, particularly women who had been abandoned or had left abusive spouses.

> *Stress [is the most negative contributor to my wellbeing] because I stay for many years without livestock and also my family because there are many things I cannot be able to do. Because sometimes I am not able to find food for the children and when all these things happen I get stress. Also I don't have a husband so since my husband died I have stress at this point* (SWLS/livestock duties interview: 38 year old, monogamous, widowed woman).

Although women who left high conflict marriages frequently returned to their birth family, they often faced significant pressure to rejoin their husbands because of traditions associated with bride price and ownership of children.[331] In addition some women came from families that were too poor to support adult daughters (one woman who was beaten badly, told us she wanted to, but could not return to her widowed mother because of her mother's poverty).

Growing awareness of non-traditional lifestyles through increased interaction with the outside world via cellphones, the Internet and higher rates of education in younger generations, may also have increased dissatisfaction. Many adults stated in wellbeing discussions that herding was demanding physically and time wise, but saw limited options for a different life, especially older residents, without education, and women, with little autonomy. Pastoral research has reported widely on increased inequity[17, 108] and wellbeing research has repeatedly found that comparisons to richer peers weaken the correlation between life satisfaction and income especially if basic needs have been met.[471, 509] In the

same vein, some investigations have concluded improvement in gender equity could lead to temporary or permanent declines in women's wellbeing, possibly because increased workplace and societal equity did not often result in proportional reductions in home responsibilities[501]. Although this conclusion was drawn from US and other wealthy nations, some research in India has suggested challenging gender gaps may be complicated in very traditional societies as an increase in female autonomy, for example through participation in self-help organisations, if in direct conflict with traditional mores, may trigger a decline in female wellbeing.[510] Furthermore, there is evidence that, as in many industrialized countries, Maasai women are taking more responsibility for income earning while still carrying the majority of household and child-rearing responsibilities.[70, 316, 350, 470]. However, despite the predominantly traditional lifestyle in the community, some Olkoroi women were aware of their national legal rights and had resisted gender restrictive customs and tribal law. For example: a woman who had left an abusive husband, journeyed to the Narok County Children's Office to seek support for retrieval of her children; another encouraged her daughter to refuse circumcision; several women interfered with paternal plans to marry off young daughters by sending the girls to family outside Olkoroi to continue their schooling, or in a few cases assisted their daughters to enroll in secondary school (at risk of significant repercussion in the form of violent threats, actual violence, and temporary banishment); and a number of educated young women refused marriage to older men (no examples of marriage refusals were observed in uneducated women).

Regardless of awareness, most Olkoroi women lacked capacity and/or material capital to access legal rights, independence, or opportunity, although some received support from male extended family, or, in a few cases, adult daughters, to build livestock assets, or to enroll younger children in secondary school. A small number of studies on female autonomy (in, for example, financial or fertility realms), including some Kenyan work, suggest that women in households with discordant marital values may exercise secret autonomy, but if unable to protect themselves or their assets, are less likely to pursue potentially beneficial initiatives.[511] This phenomenon was observed in Olkoroi in the form of secret female-owned livestock held by family living outside the community.

Many Olkoroi women lamented their lack of education or prematurely terminated education, and in a variety of contexts- during data collection, interviews, and casual conversation - addressed frustration with their lack of autonomy and independent resources:

> *[The most negative current factor in my wellbeing is…]… marriage, because you will be under control, and it is very different when you compare the time when you were with your mother* (SWLS/livestock duties interview, 20 year old, polygamous second wife).

> *[The most negative current factor in my welling is…] My husband's control* (SWLS/livestock duties interview, 24 year old, monogamous wife)

An interesting intersection of these issues was emphasized in a recent qualitative research on Maasai wellbeing in the context of conservation initiatives in Northern Tanzania.[186] Some older Maasai men continued to view education for girls as a wasted asset, but younger men saw it as valuable for both sexes. Women perceived education as important for two general reasons: increased personal and community security, but also improving land security and understanding. For their daughters, however, women saw education as a route to independence. In Olkoroi, at a women's community meeting, an older woman said that the primary constraint for women was "We have no power". She elaborated that lack of female autonomy and opportunity, and high risk of poverty were direct consequences of polygamy, arranged marriages, and traditional age gaps which frequently left women widowed early with little capacity to provide care for potentially still young children. She also stated that all of these issues had particularly negative consequences for daughter's educations.

4.3.2.2 Current Contributors and Detractors to/from Wellbeing

Lending support to the hypothesis that gender roles may in part explain proportional differences in satisfaction, the two major differences between men and women in attribution of most important contribution to current wellbeing were related to marriage and children. Although there may be some overlap of the concept of family with children and marriage, most female respondents explicitly identified children as a source of happiness as opposed to

men who were much more likely to use the word family. In further support of this interpretation, about half (12/23) of the women who explicitly identified marriage as a primary detractor from life satisfaction chose children as the most important positive contributor to their wellbeing. A woman, who had left an abusive husband stated:

> *…since I left him….I feel very comfortable to live…without him. Nowadays, I don`t have a lot of stress* (SWLS/livestock duties interview, 36 year old, polygamous second wife).

Another said her husband was the most negative influence on her current life satisfaction but:

> *There is only one thing* [that would contribute to her future happiness] *if god gives us to live for long life with my children* (38 year old, monogamous wife).

Responses to the question about current detractors to wellbeing further emphasized gender differences in the perception of marriage. For women, marriage tied with "nothing" as the most common detractor to life satisfaction (25%), a choice made by only one man. Men were much more concerned about livelihood, possibly because, as in many societies, they were primarily responsible for household economic support. Although many women in Olkoroi contributed financially as they could, responsibility for the majority of household duties left them little time when children were young, a difficulty which was compounded by opportunities limited by tribal history, culture and location. Lack of educational opportunities also meant there were few avenues for diversification once children were grown.

4.3.2.3 Future Contributors and Detractors to/from Wellbeing: Men vs Women

Responses to the question about potential future positive contributors to life satisfaction were the only ones for which there was no significant proportional difference between men and women. A possible explanation is the fatalist tendency observed in followers of traditional Maasai religion. The Christian God is often presented as actively involved with believer's lives, and/or an entity who will bring rewards to followers, but the pluralistic Maasai God/s has sometimes been represented as a somewhat capricious being who didn't engage directly in human activity, and was therefore an "unknown" force.[403, 512]

Respondents who didn't respond definitively to the wellbeing questions were as likely to respond with "Only God knows", as "I don't know", and often said both. In addition, a high proportion of both sexes viewed children as a key to a good future. In the Maasai tradition, the oldest son has responsibility for his father, and the youngest for his mother. As long as children do not fall into poverty as adults, both parents can thus expect care in their later years. Factors commonly perceived to contribute positively to life satisfaction in the longer-term may also have been less gendered than possible detractors, and/or, because of future uncertainties, were less clearly identifiable than current positive and negative effectors.

In exploring possible future detractors from wellbeing, poverty or failure, was the top concern for both men and women, albeit almost twice as much for men as for women. However, women were almost equally concerned about marital conflict which appeared to be more likely to lead to poverty for women. In an echo of the high proportion of women who identified marriage as the most negative current contributor to their wellbeing, again only one man foresaw marital conflict as a possible future problem. The most common fears of poverty and marital conflict for women, were, based on existing demography in the community, strongly connected. The women who were most likely to be poor in the community were those who were widowed, abandoned, or who chose to leave a marriage. Poverty affected older men, but even when poor, they were rarely alone, whereas for women, being alone, regardless of cause, appeared to be frequently related to vulnerability.

4.3.3 Explanatory Wellbeing Model

Significant variables associated with increased likelihood of life satisfaction further supported the conclusions drawn from the cluster analysis, life satisfaction, and gender differences in self-reported wellbeing contributors and detractors. In particular the significance of decision-making power but not sex, perhaps explained the differences in male and female life satisfaction. Several women commented on their inability to make decisions regarding household, or livestock brought into marriage. Livestock holdings were both the most important wealth marker, and a statistically significant positive associate for wellbeing in Olkoroi. However, as the herd size variable was measure in $\log_{10}$ units, the strongest effects on wellbeing in Olkoroi would have been experienced at the lower end of livestock

holdings (as ownership increased from none or few to 10 units). Since the largest TLU owned was 78, there was a local limit to wellbeing benefit arising from livestock. From a wellbeing perspective, each additional 10 fold increase in TLUs owned was associated with almost a full category (categories differ by 4 points on the SWLS scale)[513] improvement in wellbeing (for example from neutral to satisfied to very satisfied).

Livestock can provide complete household support if holdings are large enough and are also assets for diversification and expansion of family opportunity and security. However, control and access to family livestock resources still lay almost exclusively in the hands of the male HoH which left women with little opportunity to make life changes.

> *I don't have any livestock, the husband owns everything* (SWLS/livestock duties interview: 35 year old, monogamous woman).

> *I don't own any livestock, my husband doesn't allow me* (SWLS/livestock duties interview: 32 year old, monogamous woman).

> *It is difficult…I have many cows I brought from relatives but I don't own them, they are still being controlled by my husband* (37 year old, polygamous 3rd wife).

Although Maasai women usually have jurisdiction over household matters pertaining to food and children, male HoH could withhold household funds resulting in family hunger. Any activities outside the traditional female domain usually required male permission. The Global Happiness Report has consistently found that autonomy is a significant component to national life satisfaction,[320] and several women explicitly commented on this issue during the wellbeing interviews. The positive association between wellbeing and capacity to make household decisions was likely associated, in part to the basic importance of wealth in wellbeing. In Olkoroi, position as primary HoH allowed free use of family assets, livestock or otherwise, which was customarily denied to women. Women who spoke about autonomy repeatedly referenced it as contingent on asset control. Since livestock were the predominant asset, control of livestock was a key component of autonomy. Women who owned their own animals made a clear link between this power and personal freedom:

Yes, I have [livestock] because I have a small business and when I buy any animals for my business then I must own them, the husband can't control me at all. (SWLS/livestock duties interview: 50 year old, polygamous second wife).

I own my own livestock because I don't have a husband (SWLS/livestock duties interview: 48 year old widow)

I have my own [livestock] because I don't have a husband who can prevent me so I can do all because what I have is mine. (SWLS/livestock duties interview: 50 year old, divorced, polygamous woman)

Only 4/22 (18%) HoH with no livestock self-rated above neutral life satisfaction, in comparison with 35/53 (66%) of livestock owning HoH, and larger livestock holdings were associated with increased life satisfaction. At the individual level, however, possibly because of lack of autonomy, some woman living in households with livestock were still frustrated and unhappy. Specifically, in livestock-owning households, 32/53 men (60%) self-rated above neutral life satisfaction, as opposed to 27/69 women (39%).

The only thing that I see it will improve my life, I wish I will be able to have the authority to [take] charge [of] my life, the management of my livestock, and agriculture (SWLS/livestock duties interview: 49 year old, widowed, polygamous fifth wife).

Similarly, although a number of female HoH identified lack of a MHH as the primary negative contributor to their wellbeing, some, reflecting on positive contributors, spoke of relief from of stress and persecution after leaving their husbands, despite having few or no assets and frequent dependency on extended family. The FHH of an abandoned family identified as one of the most deprived in Olkoroi, was still periodically harassed by a very abusive male HoH, despite his routine absence, and stated:

[The most negative contributor to my wellbeing] is my husband, nothing else (SWLS/livestock duties interview: 48 year old, polygamous wife)

Some of the oldest women, typically widowed and with no personal assets, if living with extended family, were highly content. Conversely, four with little family support, who lived in extreme poverty and experienced routine hunger, were among the least happy.

As noted in chapter three, children and family are highly valued in Maasai culture, so the association between number of children and life satisfaction was not unexpected, though small. Children were repeatedly referenced in the context of a good future, in the contributors/detractors discussion. However, expressed concern by some HoH about educating children, and the predominant focus of the SWLS on past and present perspectives (rather than future), may have reduced the strength of the association in the SWLS predictive model. As also discussed in chapter three, the complex associations between alcohol consumption and household vulnerabilities may explain the increase in wellbeing associated with being teetotal. Churchgoers were universally tee-total, and some (though not all) of the largest herds were owned by the men most strongly affiliated with the local missionary. As alcohol consumption was not directly questioned, more specific conclusions cannot be drawn, however, an abandoned female alcoholic with dependent children stated unequivocally that the most important possible future detractor to her wellbeing would be:

> *If I don't stop taking alcohol.* (SWLS/livestock duties interview: 40 year old, monogamous wife)

4.4 Conclusion

Livestock remained vitally important to livelihood in Olkoroi, as has been determined in other pastoral and livestock dependent community research.[108] In addition, they contributed, likely through their role as primary asset, significantly to psychological wellbeing. However, the results of this study suggested gender is a critical determinant of the degree of benefit associated with livestock ownership. It is therefore imperative to continue the push to incorporate gender perspectives into livestock-related research and development in a more meaningful manner than has been achieved to date.

Although material wealth in Olkoroi was still primarily determined by livestock holdings, many families had no/insufficient livestock to support themselves by traditional pastoralism alone. As increased livestock holdings were also positively associated with life

satisfaction, the high proportion of households with no/low livestock may have been responsible for the fact that almost 60% of community members self-rated their life satisfaction as average or less than average as opposed to satisfied/very satisfied (41%). Assessing the contribution of livestock to wellbeing was further complicated by the fact that most women lacked decision-making authority regarding livestock, with the exception of female HoH holding assets for unmarried sons. Although some women had their own animals, such holdings were typically obtained from extended family, earned independently, and/or held secretly. Thus, although the most parsimonious wellbeing model suggested larger household livestock holdings were associated with higher wellbeing, livestock benefits did not automatically translate into improvement in individual wellbeing for all.

Not just Maasai women, but Kenyan women in general, are often culturally restricted from accessing major family assets of livestock and land.[398, 514] Community discussion on privatization and subsequent allocation of communally owned land, which occurred over the entire period of this research, excluded women completely. Women also faced major challenges in acquiring and controlling their own assets, which in turn appeared to be critical in determining feelings of autonomy and wellbeing. Position as primary decision maker, but not sex, was positively correlated with life satisfaction of community members. This supports the effect of constrained autonomy rather than gender per se as a source of dissatisfaction. Of the varied self-identified contributors and detractors from life satisfaction, marriage appeared to be one of the strongest negative influences on women's lives, identified by 25% of women as a current detractor, and 21% as the most likely future detractor to life satisfaction. Lack of autonomy, inability to access productive assets both at the family level and in the greater community (for example credit), and restrictive cultural norms, appeared to constrain the ability of women to both contribute effectively to family wealth, and achieve life satisfaction. Older, widowed, Olkoroi women rarely remarried in large part because cultural narratives reduced the appeal of older women as marriage candidates. [331] Without support from extended family, single female HoH of any age appear to be more likely to become poor/er, and likely less satisfied. Unhappily married women were therefore trapped in a catch 22; an unhappy marriage reduced life satisfaction, but a broken marriage could result in poverty which also reduced life satisfaction.

Although extensive research in many different parts of the world almost consistently demonstrates that increasing opportunity for women increases family wellbeing, equity and productivity, when women are very restricted in capacity, interventions may need to be multi-level and multi-imensional.[511] Nonetheless, more nuanced perspectives on gender in project and research design may allow identification and incorporation of differences in perspectives and needs. In turn, this could facilitate female access to opportunity, more engaged participation, and consequently increased productivity, material and psychological wellbeing of all members of pastoral communities, while still respecting cultural values.

Chapter 5: Livestock Disease, Rearing Practices and Contribution to Wellbeing: Community Perceptions and Exploratory Models

5.1 Introduction

Research on rural Maasai, to date, has not always fully captured the diversity of within household priorities, perspectives and experience with livestock, including keeper views on productivity constraints. In addition, many livestock disease studies are cross-sectional only. In combination, this may limit capacity to support the movement of livestock holders out of poverty, and understand critical, temporal cause-effect relationships in disease incidence. This chapter therefore aims to provide perspective on these issues through investigation of the following questions:

- How does gender affect responsibilities for livestock tasks and HoH perceptions about the contribution of livestock to wellbeing?
- How do HoH perceive general family performance of livestock related duties, optimal, best, and worst household practices, and most important barriers to productivity?
- How do HoH understand and prioritize livestock diseases and treatments?
- Which variables, including seasonal, household and herd characteristics, are most strongly associated with size of livestock holdings, growth rates of young livestock, and livestock disease prevalence?

Development literature has repeatedly asserted that livestock are a potential route out of poverty for the global poor, especially the 1-2 billion smallholders who are already at least partially livestock dependent.[29, 243, 515-518] However, perspectives on how to most effectively use livestock to alleviate poverty vary substantially among livestock keepers, researchers, development agencies, politicians, and commercially interested parties.[264] The opinions of keepers may be affected by personal priorities, socioeconomic status (SES), geographic location, culture, and gender. The priorities of other actors may be influenced by personal, national, international, organizational and/or economic agendas.[45, 83, 264] Impediments to increased productivity identified by non-keepers, include: ability to intensify production;[243,

[244] number of, and efficiency of processing facilities;[10, 243, 248, 258, 519, 520] diverse aspects of technology,[8] from market communication[521] to artificial insemination[522, 523]; participation in local and global markets;[147, 524, 525] livestock disease[29] especially zoonoses[9, 79]; access to specialty breeds;[18, 302, 518, 526] and recently, the contribution of livestock to GCC.[527] Surmounting these barriers is sometimes presented as critical to all livestock keepers,[29] but it has also been acknowledged that commercial concerns may be less relevant for the most poor.[10] For the very poor, building livestock holdings,[16] and for women, access to and control over both family and personal livestock assets are frequently more relevant issues.[528]

In surveys, pastoralists frequently identify livestock disease and the demands of dry seasons/droughts as livelihood challenges. A related issue commonly raised, is infrastructure deficiency, from medical and veterinary to education.[318, 339, 342, 454, 529-532] Fewer studies report pastoral concern about market access.[529, 531] Some academics perceive a disproportionate emphasis on market solutions for poverty reduction, and have pointed out that market concerns of traditional pastoralists are significantly different from those of non-extensive livestock farmers. [66] Intensified commercialization of livestock-rearing may also reduce traditional female control over assets such as milk and milk byproducts.[147, 533, 534] In a major review of livestock development projects, the difficulties of the poor were succinctly summarized as livestock acquisition, maintenance, retention, and marketing. The respective constraints for each were identified as: lack of funds and/or credit; disease, inability to access veterinary resources, and fodder access; and location, poor infrastructure, and trade barriers.[16] Although 20 years old, the review remains valid and highly cited, but lacked a gendered perspective (women were mentioned only twice) albeit stating, “Livestock are particularly important for women, for whom they represent one of the most widely held and important assets, and one of the most rewarding income-generating activities available”.[16]

Location constrains rural agriculture regardless of SES.[46, 295, 535-537] Mobility and political marginalization[63, 68, 538, 539] may add to pastoralist difficulties. Frequent drought and limited veterinary services in ASAL territories[540] exacerbate the impact of livestock diseases and pasture/fodder deficits. The poorest keepers, and especially women,[541] however, face additional challenges that reduce the return on their efforts. Women are often less able to access resources to improve productivity.[542] Heffernan found farmers below the poverty line

earned 50% less from their livestock than those above.[515] Research in poor, non-pastoral communities in Nyanza, concluded livestock improved household security, but substantively increased workload for women and children, [543] as has been observed in pastoralists generally,[544] and the Maasai specifically.[371] An older Maasai study concluded that wealthy pastoralists managed five times more livestock per person than the poor, with repercussions for productivity, time and labour management.[229] Collaborative work conducted across heterogeneous Maasai communities in East Africa reported the poor diversified from necessity, but the better-off for risk management, and growth of livestock wealth.[108] A 2016 wealth comparison study concluded diversification benefited rich Maasai households much more than poor, and diversification intensity did not effectively predict wealth.[545] Poor households may also have proportionally higher offtake because of subsistence needs[219, 546] and research by Bekure found poorest Maasai families had the highest gross output (in KSh) per animal (almost 300% more than the richest households), primarily because they sold more milk products.[547] High offtake, however, can come at the expense of household[548] consumption, and may slow young livestock growth, stress productive animals, and contribute to high pastoral pre-weaning mortalities.[549]

Livestock continue to play a central role in Maasai identity, culture, and livelihood. Even when Maasai diversify and/or ostensibly leave pastoralism, strong ties and support often remain for those following traditional life, and urbanites frequently secure assets in rural livestock.[108, 550] Thus, effective livestock-based interventions to improve health, wealth and wellbeing of the Maasai, and potentially other pastoralists, and rural livestock-dependent communities, require informed consideration of livestock-keeper relationships, especially individual perceptions, interpretations, and rationales for pastoral practice. Notwithstanding a large body of research on the Maasai, their views and needs have not always been fully acknowledged.[126, 139, 226, 371, 377, 551, 552] From colonial time until now, Maasai portrayals have veered from impoverished to wealthy, ecosystem destroyers to ecological wardens, irrational to wise, and, powerful to marginalized.[1, 376, 553-555] Galaty (2013) described pastoralists as:

> *…desperately in need of radical change and 'development' but…when it arrives they tend to suffer from it; they are traditionalists who would benefit from the innovations of modernity but they are already very much part of the modern world and must be selective in which of its elements they embrace.*[556]

It is not however, enough to gather community or household-level information and generalize.[515, 557, 558] As in most societies, within-household variation affects livelihood benefits and disadvantages.[108, 557-559] Several factors in particular appear to influence pastoral perceptions and experience. Household structure is important, including marriage status and presence of an active, MHH.[108, 218, 560, 561] SES is very influential,[218, 515, 557] especially herd size.[144, 528, 545, 558] Gender is also a critical determinant of livestock responsibilities, decision making power and opportunity.[371, 525, 528, 533, 545, 562]

Historically, pastoral productivity and poverty alleviation initiatives mainly focused on: drought recovery, [276, 563-565] productivity improvement,[376, 566-568] amelioration of service gaps,[310, 569-571] and, more recently, support for women.[572] Many projects have not achieved their intent,[16, 573] and some evidence suggests pastoralists can be reluctant to maintain interventions which require personal investment.[559, 574-576] Reasons for failures are numerous, but the more complex may be rooted in any or a combination of: traditional practice,[559] culture-specific cost-benefit analysis,[577] negative past experience,[376] and expectations of outside agencies,[576, 578] all dynamics which may be difficult to explicate or resolve. There may also be conflict between orthodox science and traditional knowledge and expertise.[45, 579] Widespread rural information poverty creates barriers to access and effective use of scientific information and tools,[515] in particular pharmaceuticals, and may create new problems, such as drug resistance.[521, 540] Some academics and professionals believe traditional keepers lack requisite knowledge.[515, 580] In worst case scenario, pastoralists are "ignorant",[230] sometimes they are experts,[330, 376, 556] and occasionally they are both.[581] Conversely, researchers have made, and continue to make errors because of failure to consider, understand[582] or respect community dynamics and priorities,[45, 579, 583] and include all SES strata, and gender.[16, 573, 584] Knowledge translation from research to practice may fail, or not even be attempted at research completion.[45, 83] Investigators may repeat the similar studies in different locations without synthesis (for example, the many individual prevalence assessments of brucellosis),[85] focus disproportionately on a small number of diseases,[83] and development professionals may make premature conclusions because of failure or inability to monitor interventions for sufficient time, or commit to changes in development paradigms.[16, 45, 83, 376, 576, 585]

One of the most basic hindrances to livestock productivity is lack of veterinary services. Unfortunately this barrier has become almost a given in most rural regions of SSA.[264, 586] Insufficient veterinary resources exacerbate two other fundamental limiters: livestock disease incidence and prevalence, and information poverty regarding disease transmission and management.[515] Furthermore there is a paucity of information on the barriers which prevent adoption of best practice. Substantial literature exists on livestock productivity and approaches for increasing productivity, but little changes in rural regions.[45] In Narok, district veterinary officers stated the DVO had enough trained personnel, but insufficient funding for service delivery. They further claimed the Maasai resisted new ideas and practices but were simultaneously dismissive of traditional beliefs and livelihood.[230] Olkoroi residents, on the other hand, stated veterinary presence was rare except in outbreaks.

5.2 Results

The data summaries and analyses for this chapter are based on the following as described in Chapter Two: the livestock duties and contribution of livestock to wellbeing portion of the livestock duties/SWLS/wellbeing interviews (2.3.4), the livestock and human disease prioritization and understanding survey (2.3.5), the HoH livestock husbandry self-assessment, and the best husbandry practices interviews (2.3.6), the baseline livestock ownership/health survey (2.4.2), and the longitudinal young livestock growth (2.4.7) and livestock health studies (2.4.6). SES variables used in the herd size, young livestock growth rates and disease burden models were obtained from the baseline household sociodemographic interview (2.4.1).

5.2.1 Livestock Duties, and Influence of Livestock on Wellbeing

All basic livestock tasks were performed by both sexes (Table 5-1). There were no differences in the proportion of men and women who herded, diagnosed, and assisted with birthing, but the remaining tasks, except milking, were more likely to be performed by men.

Table 5-1: Performance of Olkoroi Livestock Duties by Sex, 2009

Task	Men (n=59)	Women (n=91)	Chi-Square p value
Herding	53 (89.8%)	79 (86.8%)	0.5785
Disease diagnosis	58 (98.3%)	85 (93.4%)	0.1647
Disease treatment	**58 (98.3%)**	**76 (83.5%)**	**0.0042**
Livestock buying	**58 (98.3%)**	**44(48.4%)**	**<0.0001**
Livestock selling	**58 (98.3%)**	**43 (47.2%)**	**<0.0001**
Milking	**35 (59.3%)**	**91 (100%)**	**<0.0001**
Slaughtering	**57 (96.6%)**	**59 (64.8%)**	**<0.0001**
Butchering	**59 (100%)**	**76 (83.5%)**	**0.001**
Assistance at births	57 (96.6%)	85 (93.4%)	0.3937

When queried if livestock were positive contributors to wellbeing, all interviewees agreed (Table 5-2). There was no difference between men and women in choice of specific wellbeing contribution (chi-square, p= 0.35). The two most commonly identified benefits (source of food and livelihood/income) made up more than 80% of responses.

Table 5-2: Positive Contributions of Livestock to Wellbeing, 2009

How do livestock contribute to wellbeing?	Men (n=59)	Women (n=91)	Total (n=150)
Source of food	21 (35.6%)	42 (46.1%)	63 (42%)
Livelihood/income	29 (49.2%)	33 (36.3%)	62 (41.3%)
Support children	4 (6.8%)	9 (9.9%)	13 (8.7%)
Bank/Wealth	5 (8.5%)	5 (5.5%)	10 (6.7%)
Maasai identity	0 (0.0%)	2 (2.2%)	2 (1.3%)

A quarter of interviewees initially agreed that livestock could detract from wellbeing with proportionally more men in agreement (chi-square, p=0.002). Five men and nine women disagreed then elaborated on difficulties (Table 5-3). Hard work, economic risks, and cause of disease/injury were the most common detriments given. Drought was mentioned spontaneously as an intensifier of hard work and economic risk by over a third of the respondents who described detractors. The “other” responses were that livestock could be destructive to crops, and there were more important concerns in life:

Yes, yes if you have many cows and you don't have a child it is useless they are just images and pictures. (SWLS/livestock duties interview: 45 year old, polygamous woman).

Table 5-3: Do Livestock Detract from Wellbeing? If yes, how? (2009)

	Men (n=59)			Women (n=91)			Total		
	Yes	**No**	**Total**	**Yes**	**No**	**Total**	**Yes**	**No**	**Total**
Do livestock detract?	22 (37.3%)	37 (62.7%)	59 (100%)	14 (15.4%)	77 (84.6%)	91 (100%)	36 (24%)	114 (76%)	150 (100%)

Ways livestock detract			
Detractors	**Men**	**Women**	**Total**
Hard work	11 (18.6%)	11 (12.1%)	22 (14.7%)
Economic risk	7 (11.9%)	6 (6.6%)	13 (8.7%)
Cause disease/injury	7 (11.9%)	5 (5.5%)	12 (8.0%)
Other	2 (3.4%)	1 (1.1%)	3 (2.0%)
Total	**27 (45.8%)**	**23 (25.3%)**	**50 (33.3%)**

5.2.2 Livestock Disease Prioritization and Understanding

Across all disease prioritization interviews (n=124), twenty distinct livestock diseases were mentioned in initial diseases freelists. The number of diseases listed per person ranged from none to eight (one woman professed no disease knowledge), and the mean was 4.4 (5.0 and 4.0 for men and women, respectively). Table 5-4 lists the ten most frequently selected diseases in order of rank (with the total disease prioritization score), and the rank of each disease by total number of self-reported prevalent cases over the three year duration of the longitudinal livestock/human health study. The biggest discrepancy between prioritized and self-reported rank was for olodua, a local term for a small ruminant diarrheal disease, which ranked second in prevalence, but last in prioritization. Enterotoxaemia (another goat/sheep diarrheal disease) and foot and mouth disease (FMD), were four and three ranks apart, respectively, in prevalence versus prioritization. There was no sex difference in cultural competence (CC), a measure of familiarity with prioritized diseases. Mean CC was 8.73 in both men and women (standard deviation 2.65 and 2.08 respectively).

Table 5-4: Averaged Rank of Self-Selected Livestock Diseases of Local Importance (2009) and Rank of Total Self-Reported Livestock Disease Prevalence, Olkoroi (2008-2010)

Disease	**Rank by Summed Prioritization Scores**	**Rank by Total Reported Monthly Prevalent Cases May 2008-Nov. 2010**
Contagious Bovine/Caprine Pleuropneumonia (CB/CPP)	1 (1273.5)	**3 (2157)**
East Coast Fever (ECF)	2 (1240.5)	4 (780)
Trypanosomiasis	3 (1169.5)	**1 (4731)**
Enterotoxaemia	4 (985)	7 (125)
Foot and Mouth Disease	5 (918.5)	8 (43)
Heartwater	6 (835.5)	5 (179)
Redwater	7 (791)	9 (6)
Sheep and Goat Pox (SGP)	8 (751.5)	6 (161)
Anthrax	9 (735)	10 (0)
"Olodua"	10 (716.5)	**2 (2807)**

Prioritization rationales were wide-ranging (Appendix C . A "no answer" response was the second most frequent mainly due to professed lack of knowledge ("Mayiolo/I do not know", IDK), but in a few cases, due to personal reserve or interview/equipment errors. By frequency, rationales trended from more to less serious outcomes. The most frequent answers given, excluding "no answer", were mortality related ("causes mortality", most common, and "rapid onset of mortality onset", third most common) and "no/unreliable treatment" (second). Less frequent answers such as endemicity and "easily treated" were given for low mortality diseases. Zoonotic potential was rarely mentioned (2% of responses). The most frequent rationales for specific diseases were: fatal (for CB/CCPP, ECF, enterotoxaemia, FMD, SGP, and olodua); common/endemic (trypanosomiasis); no/inconsistent treatment results (heartwater); rapid mortality (redwater); and zoonotic (anthrax). When asked about disease causation, a similarly wide diversity of mechanisms was suggested (Appendix C , but, by a factor of four, IDK was the most common response overall, and the most frequent for eight of the prioritized diseases. The two exceptions were trypanosomiasis (IDK, 9.5%) for which the most common and correct response was the tsetse fly vector, and ticks (also correct vector) for heartwater (IDK, 31.3%).

Most respondents believed there were available treatments for prioritized diseases, but not always locally (Appendix C The highest "yes" response was for trypanosomiasis (96.8%), the lowest for anthrax (50%). Only three of the seven treatment answers were medications. The remainder were theoretical locations or people who "had treatments". Oxytetracycline was the most common specific treatment named for all the top ten diseases (21.4-48.8% of responses), except trypanosomiasis which was widely (82.6%) and correctly known to be treatable with Novidium or Veriben (trade names for homidium chloride and diminazene aceturate, respectively). Novidium or Veriben were also named as treatments for CB/CCPP, ECF, enterotoxaemia, FMD, and redwater, but only by two or three respondents per disease. In addition to trypanosomiasis, Novidium is recommended as a treatment for ECF and redwater by the manufacturer, but Veriben solely as a trypanosomicide. Penicillin was also identified as a medication for all diseases except SGP, but less frequently than oxytetracycline (between one and five responses per disease). Traditional remedies were mentioned by two participants, but only for FMD. The government or vets were believed to have specialty treatments (unavailable to herders) for six diseases, most frequently CB/CCPP (22.5% of respondents), followed by FMD, enterotoxaemia, anthrax, SGP, and ECF. A small number of people (one to two per disease) believed agrivets (local vendors with minimal or no training) had treatments for CB/CCPP, ECF, enterotoxaemia, and SGP. Similarly, between one and three people believed a treatment was available for anthrax, SGP, and heartwater, but was inaccessible to herders. They did not, though identify who held the treatments. Of the 38 IDK responses, 29 were women, and nine men, 24 (31% of women interviewed) and seven (15% of men) distinct individuals.

Anthrax was the most common answer (67%) when participants were asked if any of their listed diseases were zoonotic but at least one person per disease thought it was zoonotic. The next three "zoonoses" in order, were, FMD (24%), ECF (20%), and SGP (15%). Only FMD is a known zoonosis. Although not top ten ranked, seven respondents selected endoparasites, three of whom stated they could be transmitted to humans. Only two participants chose brucellosis as a priority livestock disease, but a distinct eight spontaneously identified it as a zoonosis.

5.2.3 Household Husbandry Self-Assessment and Best Husbandry Practices

Self-rated household husbandry was generally positive. More than 50% of interviewees rated their family as excellent (1) or average (2) in every aspect of rearing. Acquisition of hybrids was lowest rated, whereby 50% of ratings were poor (3). Men and women assessed household capacities similarly, except for livestock sales and pen quality. Women were less likely than men to rate livestock sales as excellent or average, and more likely to rank performance as poor, but more likely to rank pen quality as excellent, than men. Assessment rationales were not probed, but the negative ratings by women for sales were of interest, given it was the task with which they were least likely to be involved. Conversely, women had responsibility for keeping pens clean, while men most commonly built pens. Overall, milking, treatment of sick animals, and herd composition (balance of livestock species) received the most "excellent" ratings. The categories most frequently rated average were livestock purchases and sales.

Table 5-5: Heads of Households Self-Assessment of Household Husbandry Practice, Olkoroi 2009

	Men (n=51)			**Women (n=60)**			**Chi-square p value**
	1 (Excellent)	**2 (Average)**	**3 (Poor)**	**1 (Excellent)**	**2 (Average)**	**3 (Poor)**	
Herd Composition	44 (86.3%)	7 (13.7%)	0	55 (91.7%)	5 (8.3%)	0	0.36
Cross-bred ownership	2 (3.9%)	25 (49.0%)	24 (47.1%)	7 (11.7%)	23 (38.3%)	30 (50.0%)	0.24
Treatment	49 (96.1%)	2 (3.9%)	0	51 (85.9%)	9 (15.0%)	0	0.052
Vaccination	13 (25.5%)	16 (31.4%)	22 (43.1%)	11 (18.3%)	27 (45%)	22 (36.7%)	0.32
Purchasing	8 (15.7%)	31 (60.8%)	12 (25.5%)	9 (15.0%)	28 (46.7%)	23 38.3%)	0.23
Sales	**20 (39.2%)**	**29 (56.9%)**	**2 (3.9%)**	**19 (31.7%)**	**29 (48.3%)**	**12 (20.0%)**	**0.039**
Pens	**20 (39.2%)**	**27 (52.9%)**	**4 (7.8%)**	**37 (61.7%)**	**18 (30.0%)**	**5 (8.3%)**	**0.043**
Milking	50 (98.0%)	1 (2.0%)	0	58 (96.7%)	2 (3.3%)	0	0.66
Herding	35 (68.6%)	13 (25.5%)	3 (5.9%)	41 (68.3%)	17 (28.3%)	2 (3.3%)	0.79

Table 5-6 lists the most common responses from the best husbandry practice interviews: the most frequent response for each task, the top two choices for most important, best and worst single practice, the most common rationale for the top choices, and the percentage of respondents that gave the most common rationale as their first choice. Vaccination practice is not included because all interviewees agreed it should be done. Disease treatment and herding, the top two answers for most important and best practice, were selected at similar frequencies, and represented almost half the answers given for most important treatment and almost 60% for best treatment. Responses to the worst household practices question were the most diverse, but the top choice, breed quality, was double the frequency of the next most common response. Not only was "can't afford [better practice]", the most frequent rationale given for the top two worst practices, but it was also the most unequivocal of the rationales given for all "worst practices" discussed, 159/203 responses. Herding was again the second most common response.

Table 5-6: Summary of Interviews on Best Husbandry Practices (Olkoroi 2009)

Practice	Most Frequent Choice	Percentage Of Responses	Total Responses	Most frequent rationale	Percent First Choice
Best Practices for Optimising Livestock Productivity and Rationale for Choices					
Herd composition	Mixed herd	71%	110	Multipurpose	95%
Breeding	Purchase cross-bred animals	86%	101	Improves productivity	37%
Disease management	Disease treatment with prevention	41%	107	Maintain and improve productivity	50%
Buying	Careful inspection	46%	104	Avoid sick animals	13%
Selling	Sell biggest animal	37%	103	Maximise profit	84%
Pens	Open pens	39%	112	Protect from wild animals	14%
Milking	Equal split between family/ young animals	63%	112	Ensure good livestock growth	41%
Herding	Owner family herd	75%	110	Personally invested	70%

Most important, Best and Worst Household Practices					
Practice	**Most Frequent Choice**	**Percentage Of Responses**	**Total Responses**	**Most frequent rationale**	**Percent of Rationale Responses**
Most important practice	1. Treatment 2. Herding	26% 22%	219	Decreases morbidity/ mortality	64% 36%
Best practice	1. Treatment 2. Herding	29% 30%	214	Decreases morbidity/ mortality Family does	61% 51%
Worst practice	1. Cross-breeds 2. Herding	31% 16%	209	Can't afford	92% 55%

5.2.4 Self-reported Vaccination Prevalence and Timing

Only small ruminants had been recently vaccinated (Table 5-7) and only against Peste des Petits Ruminants (PPR) and SPG at the time of data collection.

Table 5-7: Owner Reported Vaccination Prevalence and Timing: Olkoroi, 2009

	Number of Owners Who Stated their Animals had been Vaccinated for:		
	Contagious Caprine Pleuropneumonia (2008)	**Sheep and Goat Pox (2009)**	**Peste des Petits Ruminants (2009)**
Vaccinated animals	14 (35% of flocks)	9 (22.5% of flocks)	24 (60% of flocks)
Did not vaccinate	26 (65% of flocks)	31 (77.5% of flocks)	16 (40% of flocks)
Cattle owners only (no small ruminants)	8	8	8
No livestock	18	18	18
No records	9	9	9
Total Households	75	75	75

5.2.5 Statistical Models of Herd Size and Young Livestock Growth Rates

HoH variables included in models of herd size and young livestock growth included: sex (male), age set, marital status (married), diversification (non-traditional), number of children, and church attendance (yes). Only significant variables ($p<0.05$ for univariate, full or final models) are included in the following tables. Significant univariate HoH associations

with larger livestock holdings included: sex (male), non-traditional diversification, current marriage, and church attendance (Table 5-8). In the final adjusted model, HoH who were currently married, non-traditionally diversified, and had more children, were more likely to have larger herds, however the coefficient was small for family size. Church attendance was close to significant in the most parsimonious multivariate model (p=0.058).

Table 5-8: Unadjusted and Adjusted Parameter Estimates and Confidence Intervals (95% CI) of Head of Houshold Variables Associated with Preliminary Herd Size (TLU): Olkoroi, 2008

Variable	**Unadjusted Parameters** [95% CI]	**Full Model Adjusted Parameters** [95% C.I.]	**Final Model Adjusted Parameters** [95% CI]
Church Attendance [Yes]	**2.46 [1.02, 5.97]**	1.98 [0.92, 4.26]	1.98 [0.98, 4.01]
Current status [Married]	**7.52 [3.91, 14.5]**	**5.44 [2.44, 12.13]**	**6.24 [3.43, 11.35]**
Diversification [Non-traditional]	**3.63 [1.74, 7.47]**	**2.23 [1.13, 4.40]**	**2.15 [1.16, 4.01]**
Number of children	1.13 [1.03, 1.24]	1.06 [0.973, 1.16]	**1.09 [1.02, 1.17]**
Sex [Male]	**4.81 [2.43, 9.52]**	1.63 [0.757, 3.52]	

In univariate models (Table 5-9), significant variables associated with faster young livestock growth rates, were: younger livestock age, "normal" climate (non-drought/transition period), and species. No HoH variables were associated with growth rates. In the final adjusted model, species, normal climate, and younger livestock age were significant. Larger families were associated with marginally slower growth.

Table 5-9: Unadjusted and Adjusted Parameter Estimates and 95% Confidence Intervals (95% CI) of Variables Associated with Young Livestock Growth Rates: Olkoroi, May 2009-November 2010

Variable	**Unadjusted Coefficients** [95% CI]	**Adjusted Coefficients Full Model** [95% C.I.]	**Adjusted Coefficients Final Model** [95% CI]
Livestock Variables			
Animal Type			
Cattle vs Goats	**0.46 [0.071, 0.85]**	**1.08 [0.35, 1.81]**	**0.99 [0.62, 1.37]**
Sheep vs Goats	**0.88 [0.55, 1.21]**	**0.83 [0.45, 1.21]**	**0.96 [0.66, 1.26]**
Animal Age [Older]	**-0.01 [-0.01,-0.005]**	**-0.007 [-0.012,-0.0032]**	**-0.008 [-0.010,-0.005]**
Time Period			
Normal vs Transition	**1.34 [0.86, 1.82]**	**1.41 [1.01, 1.83]**	**1.44 [1.00, 1.87]**
Drought vs Transition	0.14 [-0.29, 0.58]	0.36 [-0.018, 0.75]	0.32 [-.10, 0.73]
HoH Variables			
Number of Children	-.015 [-0.031, 0.01]	**-0.048 [-0.081, -0.015]**	**-0.040 [-0.061,-0.018]**

5.2.6 Exploratory Disease Prevalence Models

5.2.6.1 Small Ruminant Disease Prevalence

In addition to climate and livestock variable tested in other models, herd related variables tested for association with disease prevalence included mixed (cattle and small ruminants) versus small ruminant-only holdings, herd size (log TLU), and animal migration during drought/dry season (yes). Univariate and multivariate analysis of total small ruminant disease prevalence revealed no association with any climate, herd or HoH related variables except for a small increase in the May-June period (versus January-February). However, in univariate models of the most common owner-reported disease, olodua, variables significantly correlated with decreased disease frequency (Table 5-10), included: drought, post-drought and the March-April period, HoH sex (male), current marriage, greater diversification, and larger herds. Prevalence increased in May-June. In the final, adjusted multivariate model, decreased olodua burden was associated with: drought and post-drought conditions, the March-April bimonthly period, larger herds and greater HoH diversification. Higher frequency of disease was associated with the May-June and July-August periods. Only significant variables are included in the table.

Table 5-10: Unadjusted and Adjusted Odds Ratios (O.R.) and 95% Confidence Intervals (95% CI) of Variables Associated with "Olodua" Prevalence in Small ruminants

Variable	**Unadjusted O.R.** [95% C.I.]	**Adjusted O.R Full Model** [95% CI]	**Adjusted O.R Final Model** [95% CI]
Climate Period			
Trans. vs Normal	**0.40 [0.29, 0.54]**	**0.33 [0.25, 0.44]**	**0.33 [0.24, 0.45]**
Drought vs Normal	**0.24 [0.13, 0.43]**	**0.12 [0.073, 0.20]**	**0.12 [0.072,0.20]**
Bimonthly Period			
March-April vs Jan.-Feb.	**0.60 [0.37, 0.98]**	**0.49 [0.32, 0.76]**	**0.49 [0.32, 0.76]**
May-June vs Jan.-Feb.	**1.79 [1.38, 2.33]**	**2.03 [1.54, 2.67]**	**2.11 [1.61, 2.79]**
July-Aug. vs Jan.-Feb.	1.42 [0.96, 2.09]	**1.68 [1.12, 2.51]**	**1.73 [1.16, 2.58]**
Nov.-Dec. vs Jan.-Feb.	**0.69 [0.49, 0.98]**	0.78 [0.55, 1.11]	
HoH Variables			
Sex [Male]	**0.594 [0.42, 0.85]**	0.71 [0.39, 1.30]	
Marital Status [Married]	**0.61 [0.43, 0.88]**	1.07 [0.68, 1.68]	
Diversification [Non-traditional]	**0.63 [0.41, 0.97]**	**0.54 [0.31, 0.92]**	**0.56 [0.40, 0.78]**
Herd Related Variables			
Herd size [log TLU]	**0.63 [0.43, 0.90]**	0.69 [0.439, 1.10]	**0.54 [0.39, 0.75]**

5.2.6.2 Cattle Disease Prevalence

In univariate analysis, no specific bimonthly period was associated with total cattle disease prevalence, but the transition between drought and normal climate was significantly correlated with a decreased frequency of reported disease (Table 5-11). HoH characteristics associated with lower disease prevalence were: current marriage, church attendance and larger herds. The same variables were significant in the adjusted multivariate model, with the addition of the drought period, and exclusion of herd size. Only significant variables are included in the table.

Table 5-11: Unadjusted and Adjusted Odds Ratios (O.R.) and 95% Confidence Intervals (95% CI) of Variables Associated with Total Cattle Disease Prevalence

Variable	**Unadjusted O.R. Full Model** [95% C.I.]	**Adjusted O.R Final Model** [95% CI]	**Adjusted O.R** [95% CI]
Climate Period			
Transition vs Normal	**0.61 [0.49, 0.75]**	**0.56 [0.45, 0.69]**	**0.58 [0.46, 0.72]**
Drought vs Normal	0.78 [0.59, 1.03]	**0.55 [0.43, 0.70]**	**0.55 [0.43, 0.71]**
Owner/Owner Determined Variables			
Marital Status [Married]	**0.72 [0.58, 0.89]**	0.73 [0.53, 1.02]	**0.73 [0.61, 0.86]**
Church Attendance [Yes]	**0.70 [0.53, 0.90]**	**0.70 [0.49, 0.98]**	**0.68 [0.53, 0.83]**
Herd Related Variables			
Herd size [log TLU]	**0.60 [0.44, 0.82]**	**0.76 [0.59, 0.99]**	

5.2.6.3 Cattle Trypanosomiasis Prevalence

The March/April period was associated with increased Trypanosomiasis prevalence in both univariate and adjusted multivariate analysis but no correlation was found with the major climate periods. Household variables individually associated with decreased disease prevalence were current marriage, church attendance, and larger herds (Table 5-12). In the adjusted multivariate model, HoH characteristics associated with reduction of trypanosomiasis frequency were marriage and church attendance. Only significant variables are included in the table below.

Table 5-12: Unadjusted and Adjusted Odds Ratios (O.R.) and 95% Confidence Intervals (95% CI) of Variables Associated with Trypanosomiasis Prevalence in Cattle

Variable	**Unadjusted O.R.** [95% C.I.]	**Adjusted O.R. Full Model** [95% CI]	**Adjusted O.R. Final Model** [95% CI]
Bimonthly Period			
March-April (versus Jan.-Feb.)	**1.28 [1.19, 1.51]**	**1.26 [1.07, 1.50]**	**1.28 [1.08, 1.51]**
Owner/Owner Determined Variables			
Marital Status [Married]	**0.75 [0.63, 0.88]**	**0.78 [0.62, 0.99]**	**0.76 [0.67, 0.86]**
Church Attendance [Yes]	**0.72 [0.57, 0.91]**	**0.75 [0.56, 1.01]**	**0.72 [0.59, 0.89]**
Herd Related Variables			
Herd size [log TLU]	**0.66 [0.50, 0.88]**	0.89 [0.71, 1.10]	

5.3 Discussion

5.3.1 Perceptions about the Contribution of Livestock to Wellbeing, and the Relationship between Gender and Livestock Responsibilities

A positive association of livestock with wellbeing was universal in Olkoroi, even in households with no animals, but only a small proportion of respondents felt that livestock could negatively affect wellbeing. The identification of high labour demands as the most frequent negative association, was possibly influenced by conjunction of the interviews with a drought. Drought incurred extra work such as forage collection, long distance movement of animals (and family separation), and has been frequently identified and prioritized by pastoralists as a challenge and productivity barrier.[318, 454, 529] No Olkoroi respondents identified livestock disease or lack of veterinary resources as a contributor to detrimental effects of livestock, possibly because there had been no recent major disease outbreaks or

because of a sense of resignation about endemic diseases and infrastructural deficiencies. Alternatively, labour demands could have been inclusive of disease management.

Pastoral research has historically ascribed livestock responsibilities predominantly to men.[329, 587-589] Milking, sales of milk/milk products, care for sick animals, and sometimes small animal husbandry, are the tasks most likely to be attributed to women.[108, 371, 454, 512, 528, 587, 590-592] Counter to this representation, some authors claim women's roles have been extensively ignored[74, 147, 226, 371, 534, 593] and Gifford-Gonzalez referred to the "…prevailing androcentrism of most ethnographic literature on pastoralists".[594] A widely cited 1983 paper found men spent 4-7.9 fold more time on livestock work than women,[588] and it has been suggested this may reflect past patterns.[371] Interestingly, it is rarely remarked upon that the study reported girls did as much livestock labour as boys.[588] Currently, women's involvement in non-traditional duties, livestock included, is increasing.[70, 74, 108, 391, 454, 534, 595] In Olkoroi, as elsewhere,[108, 371, 391, 454] increased schooling had decreased herding contributions by children. Lost labour was sometimes replaced with hired herders, but in some families had led to increased responsibility for parents, especially women. Research by Wangui in Maasai districts concluded both sexes recognized increased female participation in livestock duties, but under-estimated their contribution. Specifically, she observed men were perceived to do more total work, although women spent more time with livestock, and performed statistically more milking, sales of milk/milk-products, and fodder collection, for a greater overall time input. Men still carried out more disease treatment, and herding.[371, 596] In Olkoroi, although men were proportionally more active in most aspects of livestock keeping, overall participation was high for both sexes. Even the activity least performed by women, trading, was carried out by almost half of the women interviewed.

5.3.2 Self-assessed Livestock Husbandry, Best Practices, and Owner Perceived Barriers to Maximising Herd Productivity

Perspectives obtained from the self-assessments and the open-ended best practice interviews were similar, but there were some contradictions within and across the interviews. For example, perceptions about herding appeared contradictory in the best practice discussions, as it was selected as both one of the most important, and best personal practices,

and yet also ranked as the second worst practice. These perspectives were not necessarily mutually exclusive, though. Livestock-centred identity, in combination with diversification pressure, droughts, and challenges to traditional pastoralism (such as land division), plausibly created conflicted feelings. HoH repeatedly claimed only owners herded and cared for their animals properly because of personal investment, and referenced strong emotional connections with their livestock, as has been widely reported about the Maasai and other pastoralist societies since first Western contacts.[93, 597, 598] Although quality of herding by pastoral owners versus hired herders has not been a research focus, a 1987 study found lower drought losses in herds managed by owners.[599] In Olkoroi, salaried herding was a low paid job and there appeared to be frequent turnover. Those who chose herding as worst performed explained they could not afford to hire good herders when outside demands precluded fulltime care by the male HoH.

Few households owned crossbreeds, yet their acquisition was by far the top choice for most productive breeding practice. Only one female HoH referred to the known problems associated with rearing crossbreeds in a low technology setting, stating Olkoroi was not ideal for such animals. Similarly, although livestock vaccinations were not prevalent, it was universally agreed that vaccination was necessary for disease management in the best practice interviews. Simultaneously, vaccinations were not mentioned as an important, best or worst practice, and were one of the lowest rated tasks in the husbandry self-assessment. A diversity of rearing challenges were identified, but costs were perceived as the primary barrier for improved practice especially for hybrid ownership. Even a single cross-bred animal would comprise one of the most expensive livestock-related expenditures most households could make, except for above ground pens owned by a few residents. Improved treatment regimens incorporating regular vaccines, and/or more effective medications and protocols would add to current treatment expenditures for most families, yet few identified treatment as a productivity constraint. In contrast, in discussion of rationales for priority disease choices, inadequate treatment availability was the second most common answer. In the same vein, while HoH self-rated household treatment practice highly, treatment knowledge was low.

Olkoroi prioritization of cross-bred livestock may reflect observations that the work of poor keepers often produces proportionately less gain than that of wealthier herders, for similar effort, even when size of holdings are comparable.[52, 108, 229, 295, 515] Hybrids are just one option for increasing productivity in locations like Olkoroi, and, given climate and disease prevalence might not be the most effective, but they may have represented a keeper vision of a change that could increase productivity without a major workload change. However, previous research has found that better care for local breeds can be as effective to increase productivity, especially if crossbreeds are not well suited to extensive conditions.[281, 600] Poverty alleviation efforts based on breed improvement have generally failed, especially in rural Africa, in part because projects often excluded poor keepers, and did not provide relevant "non-genetic" support.[601-603] A recent review of hybrid sustainability in developing countries,[601] suggested barriers, especially in rural areas, remain high, and explicitly stated that hybrids were inappropriate for extensive production. Common obstacles noted for rural regions and/or poor livestock keepers, all of which existed in Olkoroi were: high costs, inadequate infrastructure, specialty feed demands, low disease resistance and poor tolerance for high stress climates. The authors also pointed out the costs of exotic breeding programs are so high that net social benefits may be low, a rarely acknowledged consideration.[601]

5.3.3 Livestock Disease Prioritization and Understanding

Livestock diseases have been repeatedly named by both academics and keepers as one of the most important productivity constraints[16, 29, 275, 303, 515, 576, 604, 605] for poor livestock keepers. Olkoroi prioritizations were similar to the notifiable diseases list in the Kenyan Animal Diseases Act[606] as well as other surveys and ranking exercises conducted across East Africa.[301, 303, 529, 532, 607, 608] Ranking differences are likely due to variations in local ecology, veterinary infrastructure, and livestock studied. Most livestock research in SSA has focused on cattle, and consequently, there are fewer ranking studies of small stock disease. Nonetheless, available data indicated commonality between Olkoroi rankings and other Maasai communities, as well as pastoralists and rural keepers in general.[302, 605, 609-611] Olkoroi residents did not appear to prioritize cattle over small stock diseases.

Several authors have highlighted discrepancies between scientific and keeper views on livestock disease, particularly zoonoses.[29, 249, 298, 299, 339, 612] In comparing prioritizations, Perry and Grace concluded: "… the lack of consensus between the lists is striking … there is little agreement as to relative importance of diseases".[29] Keepers may underestimate frequency of diseases with variable or minimal symptoms, and overestimate diseases with distinct symptoms, or which are widely publicized.[29] Traditional keepers also often categorize by symptom,[613, 614] and some, the Maasai included, have been reported to incorporate ecological indicators into diagnostic criteria.[613, 615, 616] On the other hand, it has been suggested that experts sometimes extrapolate based on insufficient evidence.[29, 85, 617] In Olkoroi the biggest differences was between community prioritized disease and self-reported frequency rather than with government priorities.

Interpretation and comparisons of Olkoroi disease priorities with other research, were somewhat complicated by variation in terminology. In Olkoroi, ECF was prioritized highly and routinely reported in both small ruminants and cattle, but ECF is a bovine tick-borne disease (TBD). International Livestock Research Institute (ILRI) personnel suggested goat/sheep "ECF" was PPR, asserted local Maasai knew it affected only cattle, but also that PPR was recently emergent in the region, so may have been given an existent name.[618] When presented with the ILRI claim, informed residents said symptoms of the two diseases differed, and that PPR was rare, although, at the time, 60% of small ruminants had been recently vaccinated by the DVO for PPR. Likewise, olodua has been described in the literature as the Maasai word for rinderpest,[619] and as "an anaplasmosis disease with bile-staning [sic]".[607] It was used to reference PPR by Narok County officials,[620] and enterotoxaemia by a representative of the Ministry of Agriculture.[621] Multiple small ruminant diseases in Olkoroi were in part diagnosed by diarrheal symptoms, including enterotoxaemia, "ECF"/PPR, and olodua. Thus, disease misattribution in self-reports seems likely. As small ruminant mortality rates appeared to be frequently linked with diarrheal illness, lack of diagnostic clarity may represent a barrier to effective disease control and improved productivity.

It has been suggested that keepers may not prioritize low fatality diseases such as FMD.[574, 607, 622] In Olkoroi, approximately 42% of prioritization rationales were related to

mortality, but prevalence was also considered. Neither trypanosomiasis nor FMD caused major mortality, and nine of the ten interviewees who rationalized their choices with "not fatal/dangerous" did so for these two diseases. However, Trypanosomiasis was the most common self-reported disease, at a frequency almost 100% higher than the next most common disease, and was prioritized at almost twice the rate, resulting in a rank two places higher than FMD. Of those who gave endemicity as a ranking rationale, 35/50 did so for trypanosomiasis compared with six who gave the rationale for FMD.

Causal understanding was highest for vector-borne diseases, most apparent in the association of ticks with heartwater, and tsetse fly with trypanosomiasis. However, despite high prioritization of ECF, few respondents knew it was a TBD. A study of livestock TBD knowledge in East African farmers (excluding pastoralists), found that Kenyan and Tanzanian participants had low awareness of ECF causation relative to Ugandan participants, but did not explicate the difference.[623] Comparatively low awareness of TBD has also been reported in the Fulani and other pastoral communities.[624-627] In Olkoroi, there was possibly indirect understanding of very infectious diseases such as FMD, CB/CCPP, and SGP (transmitted by aerosol or secretions) which were frequently said to be caused by "air". Similar to Tanzanian research,[32, 540, 625] some Olkoroi residents stated ECF was driven by weather or grass regrowth, and some respondents associated anthrax with soil or mineral deposits. However, Trypanosomiasis was the only disease for which a specific transmission route was widely known. For bacterial diseases CC/CBPP, enterotoxaemia and anthrax, as well as the viral disease sheep and goat pox, more than 50% of responses were "IDK". Overall, as found in similar communities,[303, 540] residents "lack[ed] pathogenic explanations and the etiology…[was]…of little significance in their dealing with livestock diseases…"[628]

Numerous studies have described pastoralist familiarity with nuanced symptoms of livestock disease.[623, 624, 628-632] Indeed, the Maasai and other pastoralists have deep cultural livestock affinity, practice a variety of ethnobotanical/ethnoveterinary treatments, and use a variety of techniques to manage livestock disease in the frequent absence of orthodox veterinary resources.[249, 298, 613, 615, 625, 632] A number of studies have found pastoralists have diagnostic capacity similar to formally trained veterinary workers.[339, 624, 633, 634] However, in Olkoroi, the combination of unrestricted access to veterinary pharmaceuticals, illiteracy, and

insufficient training, as reported elsewhere,[249, 266, 304, 624, 635-637] resulted in high rates of treatment mismanagement. At every round of data collection, cases of pharmaceutical misdelivery and potentially harmful exposures were witnessed or self-reported such as: medication use inappropriate to the purported disease (for example antibiotics used for viral illness), over-use, human exposure to pesticide sprays, or consumption of milk without adherence to withholding periods, as also documented by Caudell et. al.[540] Occasional livestock mortalities occurred due to treatment overdoses. Additional factors which appeared to contribute to misuse were the limited pharmaceutical repertoire, lack of knowledge about disease agents and causation, endemicity of illnesses like Trypanosomiasis, and frustration at inability to cure some disease, for example, heartwater. When sickness persisted, owners routinely, sequentially, dosed animals with all available medications, regardless of protocols or presumptive illness, a behaviour which does not appear to have changed into the present:

> *Do you know anything about the Blue Tongue disease* [a viral disease] *for sheep? There is an outbreak of that epidemic. It is now a disaster here…I have been treating them with Tylosin (20%), Pens trip , terramycin* [all antibiotics]. *Unfortunate others heal and others die. I also used some local treatment like putting some sugar, salt, and honey on its mouth.* (Email communication from Olkoroi, June 2018: 35 year old, monogamous man, quoted by permission)

Without a shift in practice, it seemed likely that resistance to the most commonly used preventatives and medications would occur in both vectors and disease agents, if it had not already begun. As antibiotics used for human illnesses were among the commonly used veterinary medicines, potential repercussions could extend beyond livestock. Despite concern about prophylactic and treatment resistance, at present, existing human studies have been primarily hospital based, and almost no investigations have been carried out on livestock.[617] A 2016 publication on antimicrobial resistance reported only three African nations had data collection protocols for antimicrobial use in animals.[268]

In work by Heffernan, illiterate community members theorized education would improve disease understanding in younger herders,[22] and some studies have found younger, more educated pastoralists were more likely to implement disease preventatives such as vaccines.[161, 638] In Olkoroi, though, the most educated children were least likely to stay in the community and work with family livestock. In addition, other investigations have found

more comprehensive disease awareness may be associated with both age and education, reflecting the benefit of practical experience as well as scientific knowledge.[639] For women, information barriers exist inside and outside pastoral society, which may explain the lower level of livestock disease understanding found in Olkoroi women.[445] Olkoroi men were still more likely to be primarily responsible for disease treatment despite shifts in most duties, as found by other authors.[371, 528, 533] Reports also indicate, despite a few exceptions, extension training is delivered predominantly to men,[640] or may cost women more.[640] When extension support is accessible to women, they are more likely to be trained in livestock management and product processing,[641] whereas training in disease and treatment is targeted to men.[528]

5.3.3.1 Local Perceptions about Zoonoses

Zoonoses receive major attention from researchers and international bodies[9, 29, 38, 78-80, 82, 159, 299, 642-648] but not from traditional livestock keepers.[298, 299, 612, 649] Studies on zoonoses conducted in East Africa show high variability in prevalence estimates, lack of sufficient evidence to support generalized claims about both the frequency of zoonotic illness[83, 85, 650] and the associations between zoonoses frequency in livestock and keepers,[85, 651, 652] major gaps in consideration of public health and SES implications,[83] an almost complete absence of incidence research, and a lack of validity in testing systems.[89, 653] A few studies have suggested livestock keepers may experience lower frequency of diseases of potential zoonotic etiology (such as diarrheal illnesses) than those without animals.[151, 654, 655]

Pastoralists usually acknowledge zoonoses, but awareness is low,[299, 656] and they are rarely prioritized.[299, 657] Frequent misattribution,[656] and denial of both specific zoonoses and transmission pathways,[299] especially via livestock, have been reported, and were also seen in Olkoroi. The Tanzanian Health for Animals and Livelihood Improvement (HALI) project found pastoralists were almost twice as likely to believe human disease could be transmitted from wildlife as from livestock.[612] Awareness also appears to be low in rural healthcare workers (HCW),[656, 658-660] and both keepers and HCW tend to be most familiar with high profiles zoonoses such as rabies, anthrax, and endoparasites.[661] In Olkoroi, perhaps because of district studies conducted by ILRI, there was high human brucellosis awareness, but only in the context of chronic joint pain to which it was routinely attributed. Many studies claim

fevers are presumptively diagnosed as malaria throughout Africa[659, 662, 663] although there may be significant zoonotic etiology.[84, 88, 664] Conversely, a recent investigation in Mali found that 60% of patients with malaria-negative fevers as assessed by rapid diagnostic tests, actually did carry plasmodial parasites when reconfirmed via PCR.[665]

Despite its high profile, Olkoroi residents and even an educated visitor (the District Education Officer) conversationally expressed doubt about livestock-human transmission of brucellosis, and the potential spread through exposure to placental material. It was well known that milk should be boiled, but the etiological basis for the advisory was poorly understood (6.3.2). There also appeared to be a gap between identification of milk versus the source of the milk as the origin of disease. Brucellosis was spontaneously identified as a zoonosis, prioritized as a human disease, and many residents requested support for treatment of presumptive Brucellosis. As also reported in Kajiado,[666] however, it was virtually ignored (only two respondents) as a livestock disease. Similarly, although a high proportion of those who prioritized anthrax were aware it was zoonotic, and anthrax was the most commonly identified zoonotic disease, there was a gap between expressed awareness and behaviour. There had been repeated human anthrax mortality locally, most recently in both 2015 and 2016, after animals which had died from anthrax were eaten.

5.3.3.2 Vaccination Practice

In the 2008 cross-sectional human health study, all Olkoroi mothers claimed their children had received standard vaccines, suggesting human vaccinations were routine and comprehensive. In contrast, livestock vaccination appeared to happen reactively rather than proactively. According to residents, they occurred mainly when private veterinary workers solicited business, or the DVO provided free vaccines during reportable disease outbreaks. Some research on mobile pastoralists has found the converse,[100, 583, 667, 668] but Olkoroi is mostly settled and had its own medical clinic. Few investigators have explored pastoral livestock vaccination reasoning,[300, 302, 577, 669] although much has been made of the potential of One Health concurrent livestock and human healthcare delivery, especially vaccinations,[670] to increase service efficiency in rural regions. In one study of pastoral decision-making,[669] vaccination rates across Maasai, Barabaig, and Sukuma communities

were low (10%) and relatively uniform. Increased rates were positively correlated with: higher livestock morbidity, household wealth, and salaried employment. Negative associations were found with higher disease mortality, HoH age, distance from vaccine resources, and lower livestock value. The study concluded cost was the primary barrier to vaccination as also found in a study on ECF vaccine accessibility for poor keepers.[671] A Kenyan study reported that rural Maasai felt vaccination were expensive compared to other preventatives,[577] and Tanzanian work claimed the Maasai were statistically more vaccine resistant than other tribes.[161]

Motivations for livestock vaccination in Olkoroi were not studied, but some insights can be inferred from similarities to other research, self-reported vaccination frequency, and experience with two rounds of goat/sheep vaccinations delivered by the DVO which I funded as a community "thank you" at research completion. Anti-vaccine sentiment was unlikely since participation was universal, however, distance was almost certainly an inhibitor as reported by Ahamad et al.[669] Olkoroi is three hours from Narok, and DVO costs included the vaccines, fuel, vehicle use, and salaries. Barring government sponsorship, regular DVO vaccine delivery would only be potentially economically feasible for most households if the entire community collaborated as also concluded by Gwakisa from Tanzanian research.[671] Ahamad et al.[669] also suggested vaccines may not be viewed as cost-effective if vaccine-preventable diseases did not occur annually, nor affected every household when they struck. In Olkoroi, although data collected after the community vaccinations indicated that Olkoroi HoH perceived vaccines to reduce morbidity and mortality, some vaccines were short-lasting (as little as six months), and mortality following delivery was almost always blamed on the vaccinations although self-reported goat/sheep mortality was higher prior to the vaccination events. In combination, these factors may have created a perception in Olkoroi, in part legitimate, that vaccines were not a good personal investment, especially for poor families, in small holdings and/or for low value animals. Although research is limited, there is also some evidence that veterinarians and keepers alike in poor nations perceive preventative veterinary services as a public good, which likely decreases willingness of the latter to pay,[14] especially when vaccines continue to be provided for free during outbreaks of government concern.

It has been posited that risk aversion decreases adoption of disease preventatives by poor keepers.[672] Research on CBPP vaccination potential in Narok South, stated compulsory vaccination would require financial incentives to ensure universal participation.[578] In northeast Kenya, men were willing to pay more than women for CBPP vaccines, likely because they had more resources.[595] Similarly, Kenyan work which reported positive pastoral attitudes towards vaccines (as when I coordinated community vaccinations), concluded it was primarily because NGO's had covered costs[577]. Models of ECF vaccination outcomes in four pastoral regions including Narok, inferred significant potential income benefit. However, the vaccine required a continuous cold chain, was costly, and could cause serious morbidity, making it a poor candidate for wide-spread use in remote, rural regions.[673] Another Narok study found pastoralists were enthusiastic about CBPP vaccinations, but failed to follow vaccine schedules, in part due to perceived side-effects.[674] Turkana pastoralists believed late, dry seasons vaccinations increased negative side effects,[302] and in Ethiopia, vaccinations, including CC/CBPP, PPR, Anthrax and FMD, delivered during droughts resulted in

> *…no significant difference in livestock mortality, for any species, in vaccinated compared with non-vaccinated herds.*[675]

Although vaccinations are widely promoted as cost-effective for reducing disease incidence, in the case of some of the most common SSA livestock diseases, the available research raises questions about efficacy and equity in resource-poor regions, possibly rationalizes low pastoral vaccination rates, and at minimum warrants further investigation.

5.3.4 Herd Size Predictive Model

Diversification was positively correlated with herd size in Olkoroi, as in other research,[13, 107, 144, 145] although diversification options were limited, especially for women. The association was most likely because extra earnings were frequently used to support and increase TLU (for example the residents who acquired jobs in tourist lodges almost always invested in cattle). Diversified HoH had less time for livestock labour, though, and additional contributions from female HoH, children, extended family or hired herders were often required. Marital status and family size were also expected to be associated with TLU,

particularly the latter, based on work of the Homewood teams.[108] Current marriage was the most strongly correlated variable, but the magnitude of the family size effect, while significant, was small, possibly due to higher education rates for younger Maasai; the increase of one TLU owned per additional child, would not have offset minimum TLU requirements needed to support more family members via livestock alone. Adults who were not in a current marriage were typically widows or abandoned women/women who had left their marriages. Because of tribal custom and law, such women were least likely to have livestock.[108, 454, 528]

5.3.5 Young Livestock Growth Rates Model

It was expected that livestock species, age and drought would affect growth rates, but not that the post-drought transition period would have comparable constraining effects to drought. When only climate and livestock variables were modelled, drought growth rates were higher than transition rates although the magnitude of difference was small. The difference was no longer significant when owner variables were included in the model. Disease prevalence dropped in the drought, and most livestock mortality was due to starvation (lack of milk and/or grass/browse), as also reported in an Ethiopian study by Catley et al., where 70-100% of mortality was from drought effects rather than disease.[676] Ethiopian pastoralists also self-reported similar patterns.[677] In Olkoroi, immediately after rain onset, drought-exhaustion (local term) and related mortalities persisted but disease morbidity and mortality also resurged, again noted by the Catley et al. team who called for more research on this time frame.[676] Slowed, or even negative growth was uncommon during standard climate cycles, but when it occurred, as explained by owners, was typically because of disease in the young animal and/or the dam. Maternal death, resulting in loss of a direct milk source, almost always had strong negative growth effects (orphaned animals were excluded from analysis). Decreased growth rates during drought, as with mortality, were mainly due to starvation as milk production dried up, and, for "older" young animals, available browse declined. Slowed transition growth rates were likewise almost certainly due to the combination of disease increases and lingering drought effects in both the young and their mothers. However, the transition period had the smallest pool of young animals for

measurement, especially cattle, because of high mortality and abortion rates during the drought and into the rainy season (the long gestation period for cattle compared to small ruminants, meant almost no new calves were born for a year post-drought). The small number of young may have affected the validity of transition modeling.

The strong association of growth with season was unsurprising in a low input system. As well as other challenges faced by vulnerable household, drought and GCC research have identified FHH, households with low or no TLU, and the elderly at most risk for detrimental climate effects.[218, 410, 678, 679] In Olkoroi, the poorest families had no or few animals, so contributed proportionately less data, which may have affected ability to detect SES associations. Livestock growth was measured for two years, but there were several major sources of potentially interactive variability during data collection, from rainfall variation within "normal" seasonal cycles, to the drought, disease outbreaks, and disease and vector endemicity. These factors, in combination may have masked SES effects, but climate, drought, disease, and pasture availability, the focus of most research and pastoralist livelihood concerns, were also quite plausibly the primary influences on growth, especially via the impact on maternal milk production.

5.3.6 Disease Prevalence Models

In Olkoroi, total small ruminant disease prevalence was not associated with either season or drought versus regular climate cycles, with the exception of a small increase in the May-June period. In an intensive participatory investigation into caprine disease in Turkana, Bett. et al also reported no seasonal associations with goat/sheep diseases,[680] and the Turkana pastoral participants highlighted migration, markets and gifting practices as contributors to disease temporal uniformity. Narok rainfall records, the closest source of reliable measurements, indicated May (2009 and 2010) had the highest combined rainfall over the duration of the research. Analysis of the prevalence of olodua, leading cause of small ruminant mortality in Olkoroi, suggested potential association with rainfall, as the disease was more prevalent May-August. May-June are typically higher rainfall months which might have established disease with persistence into usually lower (July-August) rainfall periods. Olodua was least prevalent during the drought and the post-drought transition period.

Although diarrhea was frequently reported in small ruminants (but not cattle), it was not possible to pinpoint specific diseases/causes and it is likely that olodua encompassed a number of pathogens. The increased frequency in both typical rainy and dry months could also indicate multiple pathways/agents of disease.

Olodua prevalence was lower in the March-April interval, which, due to the 2009 drought, encompassed both an atypically dry March 2009 and a wet 2010. Rain may have been a transmission vehicle for diarrheal diseases via movement of both human and livestock feces (due to free moving livestock and open defecation) through the village and into water sources. As in the Turkana study, market purchases appeared to regularly introduce disease and in the best practice interviews, Olkoroi owners freely admitted to deliberately selling diseased animals if they could. Conversely, lack of clear seasonal associations may have reflected high, endemic goat/sheep disease burden. It is widely asserted that small ruminant production and diseases are neglected in research[75, 681-685] contributing to high morbidity and mortality rates in the holdings of poor livestock keepers.[676] Research by Otte et al. suggested SSA small ruminant mortality rates in traditional systems were close to 30%.[686] In Olkoroi goat/sheep mortality was always higher than cattle, except during the drought.

PPR was not recognized in the community, but may have been the goat/sheep ECF which was frequently self-reported. PPR is a relatively recent disease in East Africa and a small number of Kenyan studies have found seroepidemiology to be highly variable across surveyed areas, with no clear climate correlations. The main variable associated with increased risk of PPR in Kenya, thus far, has been livestock proximity, also noted to be significant in Jordanian work.[687-689] As PPR is a viral illness, close contact facilitates spread, as is the case for FMD. As mortality rates can reach 100%, PPR has had major impacts on small ruminant keepers, yet relatively little research has been carried out on the disease.[681]

In cattle, total disease burden decreased in the drought and post-drought period. In discussion of seasonal associations with livestock disease during the disease prioritization study, Olkoroi residents claimed most diseases were associated with wet seasons. The prevalence of the most commonly reported cattle disease, trypanosomiasis, however, was not affected by large scale climate cycles. Decreased total disease morbidity in cattle during drought may have been due to declines in vector populations and/or a reduction in

distribution of fecal matter. The tsetse vector of trypanosomiasis prefers warm and humid conditions, and some research has reported the vector to be vulnerable to extended dry periods[690, 691], though some Olkoroi residents said the tsetse fly was omnipresent. In contrast, at least one publication reported higher infection rates in dry seasons,[692] and yet other authors have observed no seasonal association.[693, 694] In Olkoroi, trypanosomiasis increased in the March-April interval, which is one of the warmest periods of the year and is typically a period of high rainfall, though March 2009 had unusually low precipitation. Combined rainfall and high temperatures may have increased tsetse prevalence, but highly variable associations have been found in other Kenyan and Tanzanian studies, with stronger temperature than rainfall correlations.[692, 694, 695] Results from a study in Nigeria also showed major variations, with one location exhibiting low and high incidence associated with dry and wet seasons respectively, while in other locations there were no major seasonal associations.[696] Much of the trypanosomiasis research focuses on temperature/rainfall correlations, but factors such as the tsetse species, vegetation cover, and wildlife reservoirs are also important,[692, 694] and may explain variability in research findings. An older study from Tana River, northeast of Olkoroi, found peak bovine trypanosomiasis incidence more dependent on location than season,[695] and bushy savannah, the ecosystem of Olkoroi, is classic tsetse habitat. In prioritization discussions, most Olkoroi HoH described trypanosomiasis as endemic with no specific seasonal association, which matched self-reported data on its prevalence.

Many livestock diseases in SSA exhibit variable relationships with climate, ecosystem, and region, even between nearby locations, and pastoral management practice and migration patterns may have significant effects on risk.[85, 697-699] Recent models of disease transmission suggested pastoral migration in response to season could be more important than the seasonal changes,[700] as has been suggested by pastoralists themselves.[680] GCC will almost certainly add to variability[384, 701] as has already happened with malaria distribution in Kenya.[702] Therefore generalizations may be challenging. Nonetheless, some of the most problematic livestock diseases experienced by pastoralists are more common in rainy seasons, for example TBD such as ECF,[577, 611] and parasite-induced diarrhea.[611, 703] An older guide to ticks of African domestic animals, stated almost every species was prevalent in a

wide variety of climatic zones.[704] Other TBD research is conflicted as rainfall and host availability have been reported to be associated with both increased and decreased tick prevalence.[705] Some publications assert livestock are generally more vulnerable to disease, [706] others to specific diseases when weakened by drought.[707]

Research aimed at identifying predictive risk factors for livestock disease tends to focus on individual diseases with inadequate consideration of keeper sociodemography.[275, 685] The latter is important and needs more investigation, however, the former approach is relevant given the pertinence of disease agent and vector prevalence, and climate in disease transmission, particularly in SSA and other tropical regions. Research has been limited beyond examination of owner characteristics such as wealth and education, but it should be possible to identify herder-associated variables associated with general and specific disease burdens, as disease risks are rarely uniform in humans or livestock, nor is incidence solely determined by external ecological factors. However, I found almost no association between disease prevalence and owner or livestock-associated variables in any of the disease prevalence models. Although not focused on disease, the Homewood Maasai livelihood research found little consistent association between income/livelihood strategies and a wide variety of SES variables.[108] In Olkoroi, the only HoH characteristic associated with small ruminant disease was non-traditional diversification, which was correlated with reduced olodua burden, but only 20% of HoH had been able to diversify into non-traditional revenue generation. The association might be explained by higher education which provided more opportunity for non-traditional diversification such as teaching, working in the police force, army, or as game rangers (for example, Ole Koshal, my assistant, with a grade 12 education, was one of the few HoH to regularly vaccinate his and extended family's livestock under his own initiative) and possibly more awareness of potential vaccine benefits. Non-traditional diversification tended to be into higher and/or more reliable (for example salaried) income, which could have facilitated purchase of better veterinary pharmaceuticals, more rapid and/or consistent treatments or application of preventatives. Such practices would likely result in better general livestock health, improved disease resistance, and reduced incidence and spread of disease. If olodua was primarily bacterial, then the main veterinary medicines, antibiotics, may have been more effective than against viral illness.

Observationally, poorer families were sometimes noted to delay treatment of their livestock and/or practice minimal preventative activity. Wealthier (diversified or not) and/or educated owners appeared to be more likely to use not just preventatives, but more efficacious prophylactics, and do so more regularly, behaviour also observed in Tanzania by Caudell et al.[540] An example of such practice was tick control, but, as has been repeatedly reported in Kenya and other regions of East Africa, even those who regularly applied acaricides did so exclusively by spraying rather than immersion, contrary to veterinary advice: a dip facility built by the DVO was ignored. Olkoroi residents rationalized their practice based on cost, the reason most commonly reported in the literature.[529, 708, 709] Increased herd size, the best measure of Olkoroi wealth, was also associated with a decreased olodua burden. Richer families were also more likely to move their animals during drought and dry seasons, possibly reducing average contact and transmission risks between herds.

Decreased total cattle disease and trypanosomiasis prevalence were associated with married households, which were also associated with larger herds. Such families may have had more reliable herding resources than single HoH who rarely tended livestock themselves, if they even owned livestock. More consistent herding could result in better nourished animals, which in turn might lead to increased disease resistance. Zimbabwean research on trypanosomiasis and herd size, found significant decreases in infection rate associated with larger herds,[710] although the opposite has also been reported.[575] As noted previously, church attendance for men was often correlated with opportunity to earn extra funds from the local missionary or other faith-based organisations. Married families most strongly affiliated with the local missionary had some of the largest cattle herds in the community. However, herd size was not a significant predictive variable for disease frequency in Olkoroi. Most large cattle herds were migrated out of the village during the drought, and sometimes the "regular" dry season as well. Married households with adult sons, or polygamous families, had more adults available to support migration. As absent herds contributed less data this may have biased the models or such animals may have had reduced exposure, though, again, herd movement was not associated with disease frequency.

Poorer keepers are reported to be affected by livestock disease proportionally more than those of higher SES.[515, 681] Owners of smaller herds are also more at risk for complete

loss of livestock followed by descent into extreme poverty, which may further lead to decreased capacity to rebuild after losses.[214, 681, 711, 712] Heffernan observed, almost two decades ago, that poor pastoralists often purchased subunits of veterinary medication, for example a syringe of drug rather than a bottle, sometimes in amounts insufficient for disease control.[713] One of the village stores in Olkoroi was an agrivet which sold partial units of medications exactly as described by Heffernan. An exception to the association of higher risk with smaller holdings occurs when diversified owners deliberately choose small herds for ease of management. One such household was present in Olkoroi and was anecdotally proclaimed by Ole Koshal to have the healthiest livestock in the community. The family was highly diversified in their livelihood activities, and the FHH was well educated by local standards. Deliberately small herds may be less vulnerable to disease because of higher spending on veterinary inputs, which might also be supported by effective diversification.[712]

Although Olkoroi and national disease prioritizations were similar, livestock disease control in Olkoroi bore little resemblance to national policy.[714] Some reports suggest replacements for government veterinary services drastically cut in the SAPs of the 1980s and 1990s, such as extension programs and community animal health workers (CAHW) have been able to provide effective support for rural livestock keepers. However, most research conclusions indicate the negative impact of reduced public veterinary services on rural keepers has not been ameliorated.[339, 570, 715-717] Regardless of the efficacy of veterinarian substitutes, such replacements were effectively absent from Olkoroi.

5.4 Conclusion

Pastoralists and vested outsiders are not necessarily opposed in their perceptions and priorities for supporting the most vulnerable, sustaining and improving pastoral livestock productivity. Nonetheless, major barriers exist, some of which date from colonization.[1] Despite a substantial body of existing pastoral research and continuing studies across Africa and other regions, little seems to change. Bardosh claimed: "...much scholarly research lacks clear utilitarian value and/or languishes due to weak institutional and organizational pathways to application".[45] A few publications have begun to address this relative stasis,[45, 718, 719] but infrastructural challenges make substantive change unlikely in the near future.

In Olkoroi livestock remained highly valued, central to culture and livelihood as in past and current research on rural, traditional Maasai.[108, 186, 556] Where difficulties were acknowledged by residents, they were primarily ascribed to workload and management challenges, particularly with regards to regular droughts, rather than livestock themselves. Numerous barriers to best practice were identified, but Olkoroi residents, male and female, self-regarded positively, generally viewing impediments as external to their actions. For example, while treatment limitations were frequently mentioned in rationalizing livestock disease prioritization, self-rating of household treatment practice was high.

Household attributes such as partnered status, diversification, involvement in local churches, and family size were positive predictors of herd size, and reduction in some disease burdens, but not animal growth rates. Household variables likely influenced herd productivity through effects on family stability, labour capacity, and increased household income. However, exploratory models supported community livelihood perspectives, as climate-related variables were the primary predictors of growth rates and disease frequencies. In particular, the negative impact of drought on livelihood cannot be overstated. Drought impact on fertility meant repercussions persisted well beyond the drought period. Although most diseases dropped in frequency during the drought, and sometimes following, high mortality from starvation overwhelmed any benefit.

From a more distal perspective, information poverty was a constraint to livelihood. The Narok Veterinary office did not pretend to provide rural service except during reportable outbreaks. The long-term stopgap measure of providing accessible veterinary drugs to poorly trained, often-illiterate keepers, has not been regulated or monitored. Concern exists about resistance to both the chemical used to control disease vectors, as well as curatives, some of which overlap with human medications. Access to better technological and pharmaceutical input could theoretically decrease animal disease burdens significantly, but at the time of data collection into the present (based on ongoing communication with Olkoroi), literacy barriers, lack of etiological understanding, household cost-benefit decisions, the nature and location of pastoral practice, the open ecological interface with wild disease carriers, and lack of infrastructure were bigger barriers than the specific of the diseases themselves. Furthermore, certain Western approaches to disease control, such as culling when effective vaccines are

not available, are both inappropriate in poor nations, and would not be culturally acceptable for pastoralists.[720] Even vaccines were not routinely used by most community members, because of access and affordability (as found elsewhere[577, 721]) and possibly concerns about vaccine related morbidity and mortality. Throughout my research I found urban professionals (educators, veterinary staff, and medical practitioners), quick to blame "ignorance" for perceived reluctance to follow "expert" recommendations on multiple dimensions of traditional livelihood. Some existing research and results from my disease models, however, suggest that pastoral perspectives, choices and caution as regards livestock disease management, may be entirely rational.[45, 249, 626, 667]

Information poverty, in both pastoral communities and external actors, not only reduces effectiveness and sustainability of interventions, but in some cases may negate efforts or have negative consequence,[641, 722] as has been reported for the management of Ebola in West Africa[723] and Rift Valley Fever in Kenya.[724] Interventions which may be appropriate or beneficial for non-extensive livestock systems, such as cross-bred livestock, are not necessarily effective for extensive, even settled, rural pastoralists.[601] Information delivery framed in a culturally inappropriate manner, and/or which does not effectively communicate the rational for specific practice or resource use, exacerbates the impacts of information poverty.[641] There are occasional exceptions reported in the literature,[641, 725] but women in particular are often deprived of opportunity for livestock-related education.[528, 641] Maasai traditions restricting female decision making and control over livestock further reduce potential benefits for women and increase their risk of falling into poverty. Failures of knowledge translation and negative gender effects were very evident in Olkoroi from the abandoned cattle crush, to the generally poor understanding of disease etiology and treatment options (especially in women), and improper and unsafe uses of veterinary pharmaceuticals.

In Olkoroi, water availability permitted cropping except in prolonged drought, but in many traditional pastoral locales the ecosystem has limited capacity to sustain non-livestock production systems and can rarely support intensive agriculture. Pastoralism remains one of the most logical options for maximal productivity in ecologically fragile, arid and semi-arid environments,[726] but better outcomes for development interventions will require a concerted

effort to make both initial research and follow up rational, participatory, evidence-based, culturally relevant, and contextually appropriate.[539, 722]

Chapter 6: Human Health in Olkoroi

6.1 Introduction

Although zoonotic illness is likely a relevant component of overall pastoral wellness, rural Maasai face many more fundamental roots of poverty and ill-health which may be more important, such as gender restrictions, changing family structure possibly leading to increased frequencies of FHH, information poverty and ongoing difficulty in accessing education and health-related infrastructure. This chapter seeks to explore rural, traditional Maasai health, knowledge gaps, and human-livestock disease correlations using Olkoroi as a representative community, by asking the following questions:

- What is the distribution of a set of standard health indicators (heart rate, systolic and diastolic blood pressure, middle upper arm circumference, red blood cell and platelet indices) in Olkoroi HoH?
- How do Olkoroi HoH self-perceive their health and describe their treatment seeking behaviors?
- What is the prevalence of livestock rearing and customary practices associated with potential exposure to zoonoses (slaughtering and butchering, assistance with livestock birthing, disposal of offal, and consumption of raw meat), and local disease prevention practices in Olkoroi including mosquito net use (malaria), source of household water, and treatment of water and milk (GI illnesses, and brucellosis)?
- What are community priorities and perceptions on locally important human diseases, including causation and treatment, compared with data from district reports, and self-reported disease frequencies collected via a longitudinal health study in Olkoroi?
- Which variables, of seasonal, household, and herd characteristics (including livestock disease prevalence), are most strongly associated with self-reported household adult and child disease incidence?

Comprehensive, rural health data is lacking in Africa,[727] especially Sub Saharan Africa (SSA)[728-731]. Pastoral health information is even more limited.[26, 95, 151, 448, 732-734] Many rural studies are cross-sectional,[26, 85, 735, 736] and/or use potentially biased secondary data such as DHS, clinic or hospital records.[654, 727, 737-741] The contribution of livestock to pastoral

health and wellbeing is often broadly generalized, sometimes without sufficient evidence and few studies gather data on human and livestock populations simultaneously.[27] A desire to find inexpensive solutions to health infrastructure challenges may lead to premature assumptions about low cost intervention, such as the recent enthusiasm for cell phones as medical/veterinary tools,[26, 742-744] and artificial intelligence diagnostic systems.[745] Gender,[70] social factors,[746] or even variability within and among pastoral populations are not always considered or included in study design.[298, 339]

In Kenya, the Maasai and other pastoralists were often excluded or underrepresented in DHS prior to the 2000s.[448, 732] Claims about Maasai demography, in particular fertility and STI rates, were not always evidence based, and potentially influenced by residual colonial misconceptions, racism and/or tribalism.[137, 416, 747, 748] Data quality, however, has improved with increased attention paid to arid and semi-arid lands (ASAL) in recent years. In relative terms, Kenya now has some of the best pastoral population data in Africa, but information is collected based on ethnicity rather than livelihood which may obscure health associations.[65] Persistent gaps in women's data[139] remain problematic since some research suggests that gendered cultural practices, combined with economic and infrastructural barriers, contribute to ongoing, high, pastoral maternal and infant mortality.[749-751]

Socioeconomic status (SES), gender, and age are globally important influences on health. In traditional, livestock-dependent communities, they are also critical determinants of access to household livestock resources.[70, 533] As livestock are the primary source of livelihood for pastoralists, ability to use the family livestock "bank" affects every aspect of life, including health management. Family roles may also affect risk of exposure to infectious disease, including zoonoses, via assignment of household responsibilities. The importance of the association between local context and disease risk, health-related decision making, and/or disease/treatment outcomes, has been highlighted repeatedly, but little health research in SSA attempts to explicate these important relationships.[752] A better understanding of these correlations would allow the development of more effective interventions to improve health and wellbeing in pastoral and other livestock-dependent communities.

Existing pastoral research has placed a major, possibly disproportionate, emphasis on zoonotic vulnerabilities and their contribution to the perpetuation of poverty. This emphasis

may be partly due to international funding prioritization.[250] Despite the academic agenda, studies indicate the Maasai and other pastoralists do not prioritize or even necessarily validate zoonoses conceptually,[298, 299, 612] although there are exceptions, such as the high degree of schistosomiasis awareness found in Lake Chad.[753] Furthermore, broad extrapolations of zoonotic risk and prevalence from limited studies may be questionable since the general barriers to accurate tracking of human disease in rural SSA are even higher for zoonotic illness, given the lack of diagnostic infrastructure and reliable field tests.[80, 754]

Despite claims about pastoral susceptibility to zoonoses, evidence is frequently inconsistent. For instance, zoonotic TB has been reported to be a pastoral health risk, but East African livestock prevalence appears to be low, and human prevalence variable.[160, 755] Exceptionally high frequency of cystic echinococcosis (CE) has been described in the pastoral Turkana of northern Kenya,[756-758] especially in women.[759] Zinsstag stated CE, along with brucellosis and rabies, were ubiquitous in pastoralists,[100] while Kenyan work concluded that CE had significantly increased in Maasailand over the past 30 years.[760] However, a global systematic review highlighted lack of data on CE, and found higher female risk of infection (i.e. not just pastoral women) was attributable to gendered responsibilities. Ugandan work concluded education and pastoralism were positively associated with CE awareness, and noted some risk was associated with chance introduction of the parasite, and social factors.[639] Research in non-pastoral communities found human prevalence was associated with bigger herds and lack of education.[761] This may suggest infection is less associated with pastoralism than factors common to many rural livestock keepers, pastoral or otherwise.

Discussion of zoonotic risk for pastoralists often focuses on contact, practice, and cohabitation with livestock.[230] In Ethiopia, one study found no association between diarrheal risk and housing shared with domesticated animals,[762] and another concluded pastoral children were more resistant than children from crop-dependent communities to infectious disease associated with malnutrition.[763] A systematic review on enteric parasites in pastoralists found livestock were important but that contact with dogs was the highest risk factor.[764] Claims about high brucellosis risk in pastoral communities, from productivity losses, to livestock and human morbidity and mortality burdens are also extremely common,[91, 100, 161, 273, 720, 765, 766] but a recent Kenyan systematic review reported no studies on

incidence, and "…few and fragmented evidence of the disease spatial and temporal distribution…"[85] A number of brucellosis studies have found no significant association between livestock and human seroprevalence,[161, 765, 767-770] and most investigations have measured prevalence only, raising questions of temporal bias.[771] Excess pastoral risk of brucellosis is often attributed to customary practice but a Tanzanian study found no association with higher frequencies of risky behaviours in the Maasai as compared to other tribes.[161] Although brucellosis concerns tend to focus on cattle, goat exposure has been found to be a significant correlate rather than cattle in some studies.[772, 773] In addition, an emphasis on brucellosis because of its combined impact on livestock productivity and zoonotic potential may obscure potentially more important pathogens such as Neospora. Recent Kenyan research on dairy cattle farms determined Neospora incidence was twice that of brucellosis and it was five times more likely to cause bovine abortion.[774] Most recently, a rapid brucellosis test used nation-wide in Kenyan clinics was found to have such low specificity that the study authors concluded brucellosis may have been significantly over diagnosed and unnecessarily treated.[89] A meta-analysis of DHS data from 30 SSA nations examined associations of child stunting, diarrhea and mortality risks with increased livestock ownership, and found a protective association for stunting, no association with diarrhea and a negative association with mortality. However, associations were weak (O.R. of 0.97, 1.00, and 1.04, respectively) and there was substantial inter-nation variation. Kenya OR indicated protective effect for stunting and mortality, and a negative association with diarrhea, albeit with similarly small correlations of 0.93. 1.02, and 0.90.[654]

Reports of higher infectious disease risk in pastoralists relative to settled communities, may also reflect risk factors that are a consequence of mobility and location rather than livestock contact. Some transhumant studies have concluded delayed diagnoses due to mobility increased risk of infectious disease morbidity and mortality.[158] However, tuberculosis research has identified risks such as rural location, distance from medical clinics and traditional beliefs, none of which are unique to pastoralists.[171, 775, 776] Furthermore many communities, such as Olkoroi, continue to identify as pastoral, but are effectively settled.

Settling has been reported to have negative health consequences, but this may be because settlement often follows livestock loss and impoverishment,[144] though some research

suggested mobility was correlated with nutritional and productivity advantages.[777] Even if pastoralists settle for reasons other than poverty, they may therefore still face increased health risks.[215, 778, 779] Continuation of practices that are lower risk in a mobile lifestyle may also complicate settlement. For example, accumulation of human and livestock waste concurrent with settling could increase risk of fecal-orally transmitted disease. In 2013, Narok county was ranked 10th of the 47 Kenyan counties in open defecation (OD) frequency. Seven of the counties ranked above Narok were also pastoral.[780] In 2015 the African Medical and Research Foundation (AMREF) highlighted poor rural infrastructure, cultural latrine resistance, and low maternal education rates, compounded by inadequate access to medication as significant contributors to high rates of childhood diarrhea in Narok. A Tanzanian secondary analysis of a limited data set on latrine adoption (1000 household total but only 93 practicing OD) found strong positive associations between OD practice and livestock-based livelihoods, traditional culture and cost constraints. Education was negatively associated with OD. However, for those considering latrine adoption while health was a driver, factors such as privacy and social status were also important.

Maternal and child health have improved in Kenya with the 2013 introduction of the Free Maternity Services policy, and other interventions to reduce child mortality and MDG diseases like malaria.[781, 782] Improvements, though measurable, have not increased as fast as hoped, possibly because of the low capacity of the most accessible healthcare facilities available to rural women.[749, 751, 781] However, public veterinary services, especially in rural areas, have not recovered from WB SAP cutbacks in the 1980's. Compensatory use of veterinary pharmaceuticals by pastoralists is widespread, to some benefit.[783] Although evidence suggests pastoralists often have excellent diagnostic capacity,[339, 624] low educational attainment combined with lack of effective treatments for certain livestock diseases, create potential for significant direct and indirect veterinary pharmaceutical harm to human populations, especially keepers through misuse and overuse.[266, 304, 624, 784].

6.2 Results

Data summaries and the following analyses are based on the cross-sectional baseline

sociodemographic and health study (2.4.1), the human disease prioritization study (2.3.5), and the longitudinal livestock and human disease studies (2.4.6).

6.2.1 Baseline Health Indicators

The median age of Olkoroi adult men and women was 30 (range 16-96) and 34.5 (15-68) respectively. Blood pressure (BP) range was wide, 90-200 for systolic BP, and 60-130 for diastolic BP. By current guidelines, 11 distinct individuals had potentially elevated BP: 27 were potentially in stage 1 hypertension, and 21 in stage 2.[785] One resident was in a hypertensive crisis with a BP of 200/130 (both crisis indicators) at her exam and passed away a few years later, likely from complications related to her uncontrolled hypertension.

Literature middle upper arm circumference (MUAC) for detection of malnutrition is variable.[786-791] Depending on the cut-off (23 or 24 cm), data suggested 33-50% of men, and 21-43% of women were possibly malnourished.[791] Table 6-1 used the more conservative cut-off. Self-rated health was similar in men and women, though more men than women rated their health as good or poor, and more women reported very poor health. Approximately 17% of respondents spontaneously ranked their health between good and poor (1/2). Most participants stated they routinely used a health facility when sick (all women, and 87% of men), but only 5/11 men who had sought recent treatment did so at a facility. Women reported more use of medical facilities, but also more self-treatment than men.

Table 6-1: Adult Baseline Health Indicators: Olkoroi 2008

Health Indicator	Men (maximum n=47)		Women (maximum n=49)		Total (maximum n=97)	
Mean heart rate (bpm)	71.7		76.8		74.5	
Mean blood pressure (mmHG)	n=45		n=47		n=92	
Systolic	121		110		119	
Diastolic	79		70		77.5	
	Elevated/ hypertensive BP	**Normal range**	**Elevated/ hypertensive BP**	**Normal range**	**Elevated hypertensive BP**	**Normal range**
	32	13	28	19	60	32

Health Indicator	Men (maximum n=47)				Women (maximum n=49)				Total (maximum n=97)			
Mean height	170.0 cm				157.5 cm				164.2 cm			
Middle upper arm circumference (MUAC)	**n=43**				**n=47**				**n=90**			
Mean muac	24.2 cm				23.8 cm				24.25 cm			
	Possibly malnourished		**Normal range**		**Possibly malnourished**		**Normal range**		**Possibly malnourished**		**Normal range**	
	14		29		10		37		34		56	
Self-rated health (n=95)	**1**	**½**	**2**	**3**	**1**	**1/2**	**2**	**3**	**1**	**½**	**2**	**3**
	24	5	14	3	21	11	11	6	45	16	25	9
Uses medical facility (n=92)	**Yes**		**No**		**Yes**		**No**		**Yes**		**No**	
	39		6		47		0		86		6	
Sick in the last 2 weeks	**Yes**		**No**		**Yes**		**No**		**Yes**		**No**	
	23		24		33		15		57		39	
Sought treatment (n=56)	**Yes**		**No**		**Yes**		**No**		**Yes**		**No**	
	11		12		20		13		31		25	
Treatment Choice	**Men (n=11)**				**Women (n=20)**				**Total (n=31)**			
Medical facility	5				13				18			
Traditional healer	4				0				4			
Self-treated	1				7				8			
No answer	1				0				1			

Three men (of 36) and two women (of 31) were anaemic based on hematocrit and hemoglobin (Hb) values below standard range, and 6 women had above normal hematocrit readings. Eight women and six men had above normal Hb range.[792] The potentially anaemic women were both older and well-provided for, but the three possibly anaemic men all came from deprived households with no livestock. All tested residents had standard granulocyte and lymphocyte counts with no readings substantially outside normal ranges.[793]

6.2.2 Health Promotion Behaviour

Self-reported frequency of preventative health practices is summarized in Table 6-2. Residents were asked about mosquito net use, source and treatment of water, pre-natal visits

(women), and behaviours associated with risk of zoonotic exposure such as milk treatment, raw meat consumption, and livestock afterbirth disposal, via the baseline sociodemographic survey. Additional information about slaughtering/butchering livestock and assistance with birthing was obtained from the wellbeing/livestock duties study. No households had home latrines. No HoH applying pesticides on crops or animals, were ever seen to wear protective equipment, and children often watched livestock being sprayed, downwind and exposed to sprays. Protective practice may have occurred in my absence, but I spent a cumulative year in the community in every month of the year except September and October and when in residence, made weekly visits to every home. In addition, milk was consumed from medicated animals with no withdrawal period. Informed witnesses reported that protective clothing was seldom used except when applying the harshest acaricides. No referral to written veterinary pharmaceutical treatment guidelines was observed, and I was told guidance was obtained verbally from agrivets or other community members.

At the baseline survey (2008), few residents used mosquito nets. Women with nets stated they had received them free from the medical clinic for maternity related risk, but also said they discarded nets when they were damaged or became dirty from the soot of wood fires in the home, even if no replacement was available. No one reported or was observed to wash or re-treat nets, and when asked, 60% of participants said they were not familiar with treated nets. Two women who had nets said they did not use them in hotter times of year.

Most adults were exposed to livestock placental material and assisted as necessary with livestock delivery. The only zoonotic exposure route whereby the majority did not engage in higher risk behavior was raw meat consumption (kidney, liver and heart). Most interviewees (almost exclusively female due to household responsibility) said they always boiled milk, primarily (78%) because of germs, "worms", or disease. Of the 13 "always" respondents who referenced a specific disease, seven believed unboiled milk caused malaria, four brucellosis, and two typhoid. Of other reasons: two said boiled milk was healthier (one noted it was better for women); three boiled to extract fat; two stated children complained about unboiled milk; and three women said they didn't know why they boiled. Of those who didn't have a reason for boiling, two said, because they were always being told to do so. Almost a third of the subjects (13/45) said they boiled on advice of a doctor, nurse, or

"people". A single respondent stated: "If you drink it straight from the cow there are no germs, but if it is left it needs to be boiled because germs get in afterwards".

A few households (three) had regular access to taps at the medical clinic or the school which were connected to less contaminated, but not treated, water from the hill reservoir. Most families collected water from natural tributaries derived from the Source, and a few from the Sand River. Specific collection points depended on proximity to homes and activity. One quarter of residents said they treated water with filters provided by a local NGO.

Table 6-2: Frequency of Health Risk/Prevention Activities

Preventative or Health Risk Behaviour	**Male (maximum n=59)**		**Female (maximum n=91)**		**Total (maximum n=150)**	
Used mosquito net	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**
	9 (19.1%)	38 (80.9%)	6 (12.2%)	43 (87.8%)	15 (15.6%)	81 (84.4%)
Handled placenta/livestock abortions (n=94)	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**
	39 (86.7%)	6 (13.3%)	40 (81.6%)	9 (18.4%)	79 (84.0%)	15 (16.0%)
Assisted with livestock delivery (n=150)	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**
	58 (98.3%)	1 (1.7%)	84 (92.3%)	7 (7.7%)	142 (94.7%)	8 (5.3%)
Performed slaughtering/butchering (n=150)	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**
	59 (100%)	0	76 (83.5%)	15 (16.5%)	135 (90%)	15 (10%)
Consumed raw offal (n=93)	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**
	15 (32.6%)	31 67.4%)	17 (36.2%)	30 (63.8%)	32 (34.4%)	61 (65.6%)
Treated milk (n=60, 57 female, 3 male)	**Always**		**Sometimes**		**Never**	
	45 (75.0%)		13 (21.7%)		2 (3.3%)	
Treated water	**Yes**		**No**			
	22 (23.4%)		72 (76.6%)			
Prenatal consultations (n=29)	**0**		**1-2**		**More than 2**	
	6 (20.7%)		11 (37.9%)		12 (41.4%)	

6.2.3 Human Disease Prioritization, Understanding and Rationalizations

Participants in the livestock and human disease prioritization study named 22 distinct human diseases in total. Diseases named in individuals interviews ranged between one and eight, with a mean of 3.5 (3.7 and 3.3 for men and women), fewer than the mean number of livestock diseases listed. Table 6-3 lists prioritized diseases from HoH interviews, self-reported incidence of the same diseases from 2009-2010, and the ten diseases most frequently reported at clinics district-wide for 2007 (no data was available for 2008-2009 due to district data loss). Roughly half of the community prioritized diseases were also one of the district most reported illnesses, but there was some discrepancy in categorizations. Community prioritized GI complaints (stomach aches, vomiting and diarrhea) were grouped as a single category and, in total, ranked tenth, but typhoid, which was not a top ten district disease, ranked second (self-reported fourth, albeit distantly). Diarrhea was the second most common district illness and GI complaints the third most common self-reported.

Cases of all community prioritized, and the ten most common district diseases were self-reported at least once during data collection, except for HIV and intestinal worms. The clinic routinely dosed children with anthelminthics at vaccination visits (i.e. without formal diagnoses), possibly reducing prevalence. The biggest discrepancies between prioritizations and self-reported frequencies were brucellosis (prioritized third and reported eighth), HIV (sixth and not reported), and GI illnesses (tenth and reported third).

Colds and respiratory illnesses (Olkoroi and district classification, respectively) were the most commonly reported illness from both data sources. Malaria and pneumonia were the only illnesses that were prioritized highly as well as self and clinic-reported frequently. TB, typhoid and HIV, prioritized in the community, were not in the top ten district list. Other common district diseases were not prioritized nor self-reported frequently.

Table 6-3: Community Prioritization of Human Disease, Frequency of Self-Reported Illness and Frequency of Cause for Clinic Visits in Narok District

Community Prioritized Diseases	Rank by Community Prioritization (Prioritization score)	Self-Reported Incidence (rank): Jan. 2009-Nov. 2010	District-wide Clinic-Reported Diseases by Frequency
Malaria	1 (2542)	500 (2)	**Respiratory illnesses**
Typhoid	2 (1925.5)	9 (4)	**Diarrhea**
Brucellosis	3 (1901.5)	2 (8)	**Malaria**
Common cold	4 (1763)	605 (1)	**Pneumonia**
Pneumonia	5 (1552)	6 (5)	**Skin diseases**
HIV[o]	6 (1402.5)	0 (10)	**Accidents**
Arthritis	7 1368.5)	4 (6)	**UTI's[p]**
Tuberculosis	8 (1309)	1 (9)	**Intestinal worms**
STIs[q]	9 (1296)	3 (7)	**Eye infections**
GI illnesses	10 (1291.5)	132 (3)	**Arthritis**

The most common rationales (Appendix D given for prioritizations were that the illness: interfered in daily function (36% of responses, most frequently for typhoid and Brucellosis); could be fatal (21%, most frequently for malaria and pneumonia); common (11%, malaria and colds); or difficult/impossible to treat (7%, brucellosis and HIV). Understanding of disease etiology was low (Appendix D , and "I don't know" ("mayiolo") was the most frequent response (18%). The best understood associations were for typhoid (55% of those who chose typhoid identified "dirty water" as the cause), brucellosis (50% identified unboiled milk) and malaria (44.5% identified mosquitoes). However, knowledge of general association was not necessarily the same as a full causal understanding. No one mentioned feces in elaboration on "dirty water", and one respondent speaking about mosquitoes in malaria transmission claimed drinking water in which a mosquito had died caused disease. Similarly, there was almost no specific knowledge on medical treatment for

[o] Human immunodeficiency virus
[p] Urinary tract infections
[q] Sexually transmitted infections

prioritized illnesses. Most (88%) participants stated there was effective treatments available for prioritized disease (except for HIV), but almost half (46%) could not/did not explain what the treatment was (Appendix D . Of those who responded to the treatment question, most answered generic "clinic treatment". A small proportion (9%) described traditional medicines (in some cases specific plants, others spoke generally of traditional herbs), most frequently for common colds (50% of "traditional" responses) and malaria (25%).

6.2.4 Community Reported Mortalities

Mortalities between 2006 and 2016 were summarized from family reports, the clinic nurse, and personal communications (Table 6-4). Mortalities in adults were approximately proportional to the Olkoroi sex demographic, but most male deaths were of elderly/culturally "retired" individuals. In women, deaths were distributed almost equally between the elderly, the middle-aged (past child-bearing age but still independent), and young (child-bearing age). In men, deaths were roughly half chronic and half infectious, but in women, only a quarter of the deaths appeared to be from chronic disease. The two unknown causes of adult death may have been infectious (the female death reported to be due to "ulcers", the male, "typhoid").Infant (sex unreported) death was predominantly associated with premature birth: no information was available on specific causes of prematurity. Only one reported mortality occurred in an older child, after hospitalization with a reported kidney-related illness (exact diagnosis unknown). Two children died at under a year from respiratory illnesses.

Table 6-4: Community Reported Causes of Mortality, 2006-2016

	Cause of Death						
Sex and Age Category	**Premature delivery**	**Respiratory (Pneumonia+ unknown)**	**Unknown (kidney related)**				
Infants	10	2					**12**
Pre-teen	N/A		1 (male)				**1**
Women	**Cancer**	**TB**	**HIV**	**Unknown**	**Hypertension**	**Violence**	
Elderly	1 (cervical)	2					**3**
Middle-aged		1	1		1		**3**
Young				1		1	**2**
Men	**Cancer**	**TB**	**HIV**	**MI**	**Old Age**	**Unknown**	
Elderly	1 (prostate)	1		1	1	1	**5**
Middle-aged			1				**1**
							27

6.2.5 Exploratory Models of Self-Reported Human Morbidity

Human disease models were based on May 2009-November 2010 period (a total of 19 months). Climate related variables tested for association with total incident human disease and the three most common self-reported diseases (malaria, respiratory infections, and GI illness) were: drought versus post-drought climate period and bimonthly periods (compared to January-February). HoH variables tested included: age set, church attendance, diversification, marital status, and number of children. Herd related variables were: herd size, migration versus none, total small ruminant disease and total cattle disease.

Because of the number of variables tested, and small number of significant findings, only significant variables are reported in the following tables. When only single variables were significant, the individual coefficients are the same as the final model coefficients. No livestock-related variables were associated ($p<0.05$) with self-reported morbidity in adults or children for either the most common diseases (malaria, respiratory infections, and GI illnesses), or total morbidity. Variables associated with HoH-reported disease in children were drought, bimonthly periods, and church attendance (Table 6-5). Drought reduced malaria and total disease frequency, but not respiratory infections or GI illnesses, while

specific bimonthly periods were significant for all disease categories except GI diseases. For adults (Table 6-6), specific bimonthly time periods were the only significant variable for malaria, respiratory infections and total disease (non-chronic). The "away" variable, used to identify families which sent their livestock away to relatives or distant grazing grounds during drought and/or dry periods, was the only significant variable associated with incidence GI illness (decreased) in adults.

Table 6-5: Unadjusted and Adjusted Parameter Estimates and 95% CI of Climate, SES, and Livestock-Related Variables Associated with Total Self-Reported Morbidity, Malaria, Respiratory Infections, and GI Illness in Children

Variable	**Unadjusted Coefficients** [95% CI]	**Adjusted Coefficients Full Model** [95% C.I.]	**Adjusted Coefficients Final Model** [95% CI]
Malaria			
Drought (versus regular rainfall)	**0.540 [0.410, 0.711]**	**0.371 [0.233, 0.591]**	**0.471 [0.354, 0.628]**
Bimonthly period			
March-April	**2.13 [1.04, 4.37]**	1.01 [0.475, 2.49]	**2.12 [1.04, 4.31]**
May-June	**2.08 [1.21, 3.60]**	**2.51 [1.36, 4.62]**	**2.81 [1.65, 4.77]**
July-Aug	1.49 [0.773, 2.86]	1.48 [0.638, 3.46]	**2.00 [1.04, 3.86]**
Sept-Oct	1.64 [0.961, 2.79]	**2.13 [1.15, 3.92]**	**2.20 [1.29, 3.75]**
Church attendance	**0.580 [0.407, 0.827]**	**0.292 [0.154, 0.555]**	**0.582 [0.409, 0.829]**
Respiratory Infections			
Bimonthly period			
March-April	**2.17 [1.28, 3.69]**		
May-June	**1.86 [1.19, 2.90]**		
Nov-Dec	**2.53 [1.53, 4.21]**		
GI			
Church attendance	**0.263 [0.098, 0.704]**		
Total Disease			
Drought	**0.708 [0.600, 0.835]**	**0.697 [0.502, 0.967]**	**0.668 [0.550, 0.810]**
Bimonthly Period			
March-April	**1.97 [1.35, 2.87]**	1.12 [0.644, 1.93]	**1.96 [1.35, 2.85]**
May-June	**1.91 [1.41, 2.58]**	**2.00 [1.18, 3.38]**	**2.30 [1.66, 3.19]**
July-Aug	1.04 [0.807, 1.35]	1.21 [0.723, 2.03]	**1.59 [1.12, 2.24]**
Sept-Oct	1.26 [0.930, 1.72]	1.16 [0.676, 1.98]	**1.52 [1.08, 2.14]**
Nov-Dec	1.43 [0.929, 2.20]	1.23 [0.588, 2.59]	**1.62 [1.04, 2.54]**
Church attendance	**0.700 [0.540, 0.908]**	**0.501 [0.335, 0.763]**	**0.690 [0.539, 0.906]**

Table 6-6:Adjusted Parameter Estimates and 95% Confidence Intervals (95% CI) of Climate, SES, and Livestock-Related Variables Associated with Total Self-Reported Morbidity, Malaria, Respiratory Infections, and GI Illness Frequency in Adults

Variable	Unadjusted/Adjusted Coefficients Final Model [95% CI]
Malaria	
Bimonthly period	
July-Aug	**0.247 [0.122, 0.499]**
Respiratory Infections	
Bimonthly period	
Nov-Dec	**2.30 [1.26, 4.20]**
Gastrointestinal infections	
Away	**0.420 [0.220, 0.802]**
Total Morbidity	
Bimonthly period	
July-Aug	**0.592 [0.410, 0.854]**

6.3 Discussion

6.3.1 Baseline Health

Average heart rates and blood indices in assessed residents were in a healthy range. Average SBP for participating men was at the low end of "elevated" blood pressure, a potential indicator of pre-hypertension, but was averaged across all ages; current guidelines move upwards with age. However, a relatively large proportion of subjects were possibly at least borderline hypertensive, and only a third met "healthy" BP standards for both SBP and DBP (less than 120 SBP and 80 DBP)[794]. As the assessment was intended to provide a preliminary cross-sectional overview of community health, there was no follow-up. Higher readings may have resulted from natural fluctuations (only one measurement was taken) or nervousness at the physical examination, and those with health concerns may have been more

inclined to participate. As single BP measurements are not recommended for clinical assessment, the values reported may over-estimate the prevalence of potential hypertension.

Higher mean BP and increased cardiovascular disease risks in the global south are primarily attributed to a higher prevalence of risk factors, demographic changes, and infrastructural limitations on disease prevention,[795] although a recent hypothesis implicated malaria as a possible contributor.[796] Two Kenyan rural studies on cardiovascular risk factors, each of which looked at three tribes including Maasai participants, found no tribal BP differences, very similar mean BPs to our study, and comparable differences between men and women. Both studies used older guidelines, SBP ≥ 140 and/or DBP ≥ 90 mm Hg, and measured total hypertension prevalence at 12 and 8% respectively.[47, 797] In contrast, older work from Tanzania recorded a prevalence of 25 and 19% in men and women.[798] Using the same criteria, 24% of participating Olkoroi residents were hypertensive, 15% of women, and 30% of men. Only one of the Kenyan studies distinguished mean male and female BP, but as in our data, found that men had double the female rate of hypertension.[47]

Two Tanzanian studies, one comparing rural and urban hypertension, and the other cardiovascular disease risks in 1987 and 1998, both concluded mean BP was increasing in Maasai communities. The shift was attributed to diet changes including increased salt intake, reduced physical activity and increased obesity.[798, 799] Similar trends have been observed in SSA generally.[795] In Olkoroi, children were more likely to attend school than in the past, and consequently fewer men followed the physically demanding warrior life stage. Reduced herd sizes and settlement may also have reduced physical activity. Nonetheless, few residents were overweight, and the majority were active with herding and long, twice-weekly market trips by foot or bicycle. Severe hypertension risk appeared to be mostly familial, with high BPs found in both younger and older members of a few families (for example, members of the same family as the female mortality with extreme hypertension, also had very high BP).

The Olkoroi nurse stated malnutrition was uncommon, relative to even nearby communities, due to supplementation of livestock rearing with cropping in most families. The Maasai are known for their low BMI, slenderness may be culturally valued, food is traditionally restricted in pregnant women to limit incidence of obstructed labour,[800, 801] and droughts cause recurrent deprivation cycles.[1, 383, 802-804] Numerous studies have found high

levels of underweight and malnourishment among the Maasai, dating back almost a century, with men more likely to be underweight than women. The long-term consistency of such findings in combination with cultural traditions may imply "underweight" is a Maasai norm.[151, 805, 806] One study ascribed high underweight prevalence in part to traditional livelihood[805] but in a study of Narok schoolchildren, more than 40% said that food was insufficient at home and in school.[807] Tanzanian research reported high levels of vitamin deficiencies in Maasai women, but there is little comparative data, and it is thought such deficiencies are widespread in Tanzania.[808] Thus, despite MUAC implications, in Olkoroi some "malnourished" individuals may have been relatively healthy and nourished by Maasai standards, especially contrasted with reported underweight prevalence as high as 75% in Kajiado county.[805] Still, ten Olkoroi households experienced routine hunger (observed, and self-reported in both the longitudinal health and the life satisfaction studies). Based on the more conservative MUAC cut-off, field observations and SES data, eight of the 14 men were likely truly under-nourished. Four were among the poorest in the village, and experienced periodic food deprivation, and four had serious chronic illness. Three were married and five were single (two widowed/abandoned, three never married). Of the remaining six who met malnourished criteria, four were economically secure and unlikely to be deprived (though one was a heavy khat user). Of the ten women, five were de facto or de jure single HoH, and suffered significant ongoing deprivation. Three appeared to be well-provided for. There was insufficient information to draw conclusions about two of the men and two of the women.

Gender may have contributed to differences in the baseline self-reports of recent illness. Several women described difficulty in gaining male permission to seek medical treatment for themselves or their children, or accessing better care when the local clinic could not resolve illness. Physical punishment of three separate women was reported for taking sick children to the clinic when the male HoH was absent. More than half of the adult female deaths were potentially premature, as they occurred in a context of either no, or inadequate diagnosis and/or treatment for potentially manageable illnesses. A much higher proportion of women were de facto or de jure single HoH than men, and these women often had extremely limited earning capacity. Older, widowed women were usually well-cared for by family, but a few were deprived. Many younger women with children, single HoH or married, struggled

to meet family needs. Only one woman reported depression in the longitudinal study, but many expressed frustrations in wellbeing interviews. Unhappiness, spousal violence, significant female burdens of work and responsibility, greater contact with children and potentially increased risk of infectious disease, and/or ill-health associated with child-bearing may have contributed to a real or self-perceived higher rate of illness.

A Kenyan study in non-pastoral Meru, found women were more likely to report recent illness, seek treatment, and less likely to self-treat, as in Olkoroi. The authors suggested differences might be due to child-bearing morbidity and/or women seeking self-care when taking children to clinics. They also noted a positive correlation between education and clinic attendance versus self-treatment.[809] A comparison of Kenyan subjects in western and coastal regions with the northern pastoral Samburu, similarly concluded women across all locations were more likely to seek healthcare, and slightly more likely to report current illness (68% versus 62%), but alternatively proposed that education might give female HoH confidence in self-treating themselves or children.[810] Pastoral women in Chad were more likely to self-treat,[158] possibly because of inability to access formal healthcare, also a challenge in Olkoroi. Although no women reported recent use of traditional healers, self-treatment likely included traditional remedies, and all women used community birth attendants. There may also have been reluctance to disclose self-treatment and traditional practices to a Canadian nurse. A review of traditional SSA treatments noted herbal remedies were most commonly used to treat symptoms such as fevers, or digestive complaints,[811, 812] also reported in Olkoroi. We regularly encountered male and female HoH brewing traditional herbal preparations for mild discomforts, and as general tonics.

6.3.2 Health Risks/Prevention Activities

Despite awareness of a variety of preventative health measures, inconsistency in practice was common and acknowledged in Olkoroi. Although we did not directly explore adherence failures, insights may be obtained from the disease prioritization study, the interviews about milk boiling, bed net use and ethnographic observations. Three contributors appeared important, each rooted in lack of knowledge combined with cultural perceptions. Residents had low comprehension of: disease etiology (as per the prioritization study and

milk interviews), preventative rationales (from milk interviews), and the repercussions of irregular adherence to prevention protocols (noted in milk and bed net interviews).

Most,[813, 814] but not all SSA studies[815, 816] on insecticide treated mosquito nets (ITN) have found education is correlated with higher use.[814] However, consistent, correct use is low in much of SSA, even when nets are free and awareness is high.[816-819] One Kenyan study found use was predicted more by attitude and beliefs than access.[820] In Olkoroi, net use was rare even among the most educated. No one reported or was observed to re-treat nets and in combination with a 60% claimed ignorance of ITN, a gap in understanding of the importance of the insecticidal aspects of ITN appeared likely. A systematic review on care-seeking for malaria in SSA children concluded, "…the problem was people knew how to prevent illness but rather did not believe that prevention efforts would be effective and felt illness often 'just happens'".[752] In Olkoroi there was a sense of resignation about malaria and other endemic diseases: "it [malaria] is always there, and also it affects everybody unlike Brucellosis…"

In discussion of possible negative impacts of livestock, only 11/150 respondents (Table 5-3) said livestock could be a source of disease. Although many were familiar with the link between raw milk consumption and brucellosis, in casual conversation transmission via livestock placenta was denied and unprotected exposure to livestock birthing material was routine. Milk was seen as the disease source rather than livestock, and brucellosis was not prioritized as a livestock illness. It has been hypothesized that pastoralists do not recognize zoonoses because of symptom differences in livestock and humans, temporal gaps between infections, or because specific associations may be obscured when diseases such as skin infections have multiple etiologies but similar symptoms.[298] There was some familiarity with zoonoses in Olkoroi but overall awareness and conceptual understanding were low. As reported in Tanzania, we found some confusion about which common livestock diseases were or were not zoonotic.[646] Only Anthrax was almost universally recognized as a zoonosis.

Some adherence inconsistencies in Olkoroi were likely due to conflict between health advisories, customary belief, and circumstance, as has been reported for ITN. There was high awareness of the danger of anthrax and exposure routes, and several outbreaks and mortalities had occurred in the past decade. Yet, pica was common in women, and in casual conversations it was stated that elders claimed that anthrax could be neutralized by cooking

meat with traditional herbs, or smearing the blood of a dead anthrax-infected animal on the mouths of consumers would prevent infection. Similarly, in milk treatment interviews, one woman said "This is modern tradition- there is nothing bad in unboiled milk but I boil because people said to boil". Several women also said they boiled milk regularly, but might not if children were hungry, some adults said they consumed raw milk, or water from streams while herding, and children were also seen consuming milk directly from livestock.

6.3.3 Disease Prioritization, Rationales and Understanding of Causation and Treatment

Except for arthritis, the most frequently prioritized diseases were infectious. Rationales for human disease prioritization were similar to livestock disease (5.3.3). Specifically, prioritization was mainly based on severity (HIV, typhoid, pneumonia and tuberculosis), frequency (malaria and colds) and effect on daily activities (arthritis). While it was acknowledged that colds were not usually serious, a few women spoke of a connection between colds and subsequent pneumonia in children. Malaria and pneumonia are leading causes of child mortality in SSA, but diarrhea the third major mortality driver, was prioritized last in Olkoroi (most of the category, "GI illnesses"). A similar pattern was seen in livestock diarrhea prioritization, where, despite its probable role in high young livestock mortality, it was also prioritized last. Low prioritization may be because of frequency and association with a wide variety of diseases, as with pastoral perceptions of zoonoses.[298] In humans, diarrhea accompanied malaria, food poisoning, typhoid and an unknown number of microorganismal illnesses. In livestock it was a symptom of several common diseases, and also perceived in different forms (for example, presence or absence of blood), as a disease unto itself. A review of diarrheal management in 12 SSA nations (excluding Kenya), concluded that diarrhea medical standards were low and oral rehydration interventions infrequent,[821] also reported in Narok by AMREF.[822] However, the review also found home management was sometimes as, or more effective than orthodox medical care.[821] Another review on harmful diarrheal care practices in LMIC including Kenya, concluded traditional beliefs antithetical to recovery were widespread.[823] Perceptions of Olkoroi clinic care were

not probed, but the local nurse had minimal training. If sentiments and standard of care were similar in Olkoroi, diarrhea, like malaria, may have been viewed as unavoidable.

Conversely, the high ranking of HIV, and almost universal attribution of joint pain to brucellosis, imply that diseases emphasized by public health campaigns, and/or viewed as untreatable or fatal, may be seen as more important, or education campaigns may distort perceptions. Community informants reported that five of eight female deaths in the past decade were potentially due to infectious disease, three attributed to TB, one to peptic ulcer complications, and one to HIV. At least two other confirmed cases of TB (males) were diagnosed during the study, one in Olkoroi and one in a nearby community from which children traveled daily for school. Given TB infectiousness, it seems likely there were other latent or undiagnosed cases, but regardless, in mortality terms, TB was the primary, treatable, infectious cause of death in Olkoroi women. Although TB was prioritized, it was 8th on the list, behind the common cold and HIV at positions 4 and 6. Gastric ulcers were a prioritized disease in two sets of preliminary interviews outside Olkoroi (in urban and rural Narok), and throughout the research, were a regular conversational topic. Several community members followed restricted diets due to what they reported as unresolved ulcers. Few Kenyan studies have been done on *Helicobacter pylori*, though a Nairobi prevalence study suggested rates were extraordinarily high, over 50% and 70% in adults and children respectively.[824]

A number of residents suffered from persistent illness over the research period, for which they were unable to get accurate diagnoses, effective treatment, or respite, despite repeated follow-ups at multiple facilities. Because these subjects did not report symptoms at every visit of the longitudinal study, and sometimes changed the identity of their illness, these morbidities were difficult to categorize and quantify. The resistant-to-treatment diseases tended to be of four main types: persistent GI illness, often recurrent for long periods, frequently initially diagnosed as malaria, later as typhoid, and yet remaining unresolved with standard treatments; general malaise and despondency, often accompanied by cough, almost always in women, no diagnosis, and ending either after a long, gradual recovery, or in death (eventually diagnosed as tuberculosis in two cases); long-standing, painful GI symptoms diagnosed as *H. pylori* but unresponsive to treatment; and residents who repeatedly but not consistently, reported joint pains, almost always attributed to

brucellosis. Clinic treatment of brucellosis, essentially on demand and without laboratory confirmation was common, but frequently did not bring relief. Inability to obtain diagnoses and effective treatment for persistent illness, in combination with a possible cultural tendency towards fatalism, may have contributed to a sense of resignation, lack of control, and even skepticism towards medical treatment, as well as the gap between asserted knowledge about prevention versus actual practice. Preventative health gaps have been attributed to similar sentiments in South Africa, Nigeria and Uganda.[752] High brucellosis awareness in Olkoroi may have stemmed from public education prompted by Narok studies carried out in the late '90s.[825, 826] While the recent systematic review on brucellosis in Kenya concluded livestock prevalence was high, and could reach 10% in most at-risk human populations, study tools and design precluded reliable conclusions about frequency in both populations.[85] Brucellosis treatment was one of the most expensive available at the clinic, which may have affected willingness to treat presumptive infection since the clinic was supported by user fees.

Few interviewees could correctly explain disease etiology, and, excepting malaria and brucellosis, most diseases were attributed to climate variation, as also reported in a systematic review of SSA household response to childhood illness.[752] The same review found, as in Olkoroi, frequent partial, but critically incomplete causal comprehension. This may imply insufficiency or efficacy gaps in health education, and may also partly explain preventative practice inconsistency. Partial understanding of typhoid causation was relatively high, for example, but did not translate to attitudinal change towards OD or latrine use. Strong anti-latrine attitudes were evident, and the only latrines were at the school, the medical clinic, and purpose built for me. Interviews conducted by AMREF as part of a clustered RCT for improved childhood diarrheal treatment in Narok, reported identical latrine distribution: "…there were no toilets except only in schools and the health facility".[822] A study in Maasai Kajiado, found: latrine construction was a male HoH decision; a strong correlation between education and latrine use; and widespread anti-latrine attitudes.[827] Further research is needed, but fecal-oral transmission likely contributed at least partly to high Olkoroi rates of GI illness. However, behaviors, beliefs, and incomplete/absent causal understanding combined to create a significant barrier to better fecal management, including:

- customary avoidance of human waste management
- a gap between recognition of "dirt" in disease causation and the specific "dirt" responsible
- a low prioritization of GI illness despite high self-reported and district rates
- a belief that infant fecal material was harmless (academically reported[828] and repeatedly demonstrated by observation of the way it was handled in Olkoroi)
- practices indicating livestock feces were not viewed as a potential source/serious source of disease
    - young children actively playing with livestock feces
    - use of cattle dung to pack fresh ornamental ear piercings
    - the cultural importance of cattle dung as a component of the plaster used in traditional home building (and always prepared with bare hands)

The last perception is partially supported by Henderson et al. in a paper titled after a subject quote: "We can't get worms from cow dung".[657] The authors analysed attitudes towards helminth infections and concluded that beliefs and behavior were contextually rational. For example, it was noted that GI infections were frequently and preferentially treated with herbal home remedies because of cost (none), almost inevitable reoccurrence, and observable results of treatment "efficacy" (ejection of whole worms) unlike some clinic treatments. As per the title, there was some legitimacy to the perception that cattle did not transmit harmful helminthes, as bovine helminths are generally not as harmful as parasites associated with livestock such as pigs, which are not typically reared by Maasai. Related to this conclusion are two studies which found lower helminth infection rates in Maasai children relative to other tribes.[151, 655] Also relevant to Olkoroi, the Henderson study further concluded that health outcomes were a product of a nuanced and rational trade-off between resources, survival requirements, and capacity, and that there was a significant failure of public health initiatives to productively and effectively integrate local customs, beliefs, and lived reality into medical care and interventions.[657] Additionally, as has been noted for livestock disease, perceptions of health officials did not always reflect community concerns or constraints.[29]

Participatory livestock disease ranking is a mainstay of pastoralist research,[161, 300, 302, 339, 532, 574, 577, 624, 630, 633, 829-831] but few publications include human disease prioritizations and

those that do, tend to focus on zoonoses.[299, 646] Some exploration of general rural priorities has been conducted, especially in the context of poverty reduction. In Western Kenya, crop productivity and marketing were prioritized first, livestock productivity (including disease) second, followed by three roughly equal priorities: water and sanitation, human disease and healthcare, and loss/breakdown of local resources.[832] Eastern Kenya research reported household development and livelihood security were placed ahead of community development. Participants explained that household improvements enabled individuals to focus on community advancement. Specific community infrastructure priorities included health services, education, clean water, roads, and market access.[833] Work on community risk, defined as "…exposure to potentially unfavorable circumstances, or the possibility of incurring nontrivial loss," conducted in three pastoral groups (Boran, Samburu and Rendille) found little prioritization agreement except for food and water security, likely due to both the impact and increasing unpredictability of droughts in ASAL. After food and water, roughly 1/3 of responses across all three groups expressed concern about livestock disease and healthcare access.[342] Zinsstag claimed that pastoralists were most affected by TB, acute respiratory infections, GI illnesses, STIs, and in some regions, vaccine preventable diseases and parasites. However, many publications have described disease patterns in Kenya and SSA in general, not just in pastoralists,[752] similar to that observed in Olkoroi and highlighted by Zinsstag. More recently Schelling wrote, "…human diseases that affect mobile communities are often not dissimilar to those of sedentary communities in the same area".[26]

6.3.4 Human Disease Models

6.3.4.1 Malaria

Time of year and drought were associated with malaria and were almost certainly reflective of rainfall and temperature, both of which are known to be connected to mosquito population size and subsequent malaria frequency. The exact relationship between weather and malaria incidence is complex and appears to be geographically variable, but generally, higher frequency of malaria is correlated with increased rainfall and warmer temperatures in the preceding 1-2 months (sometimes longer).[834, 835] Some research has found lower precipitation events support mosquito population growth most effectively, possibly because

extreme rainfall may disrupt breeding habitat. Several studies have been unable to show any clear relationships between temperature, rainfall and malaria.[835] Temperature and rainfall data were not collected for Olkoroi, but data from Narok town was used as an approximation. The strongest bimonthly-malaria correlation was in the May-June period, preceded in March-April by the highest combined rainfalls over the study duration. While malaria frequency in children was significantly higher in March through October, there was no specific period in which adult infections increased. The significant correlation with increased frequency in the July-October period for children may have been an anomaly as the July-August rainfalls were the lowest of the 2-year period, and in adults there were decreased incidence reports for the July-August interval. Nonetheless, August in both years had substantially higher rainfall than July. Although malaria frequency in adults was sometimes similar to children, it was generally much lower, sometimes as little as 25% of incidence in children for the same time period. It is possible that increased adult resistance with age and repeated exposure decreased symptomatic adult incidence, but in addition, malaria frequency in the January-February comparison period for adults was quite high, and the frequency of bimonthly self-reported totals over the year, fairly consistent. The drought reduced malaria frequency in children, by approximately one half, but had no effect on adult malaria frequency possibly because incidence was generally low already but also because of regular, higher-risk night exposures related to household and herding responsibilities.

HoH church attendance was protective for malaria in children. This may have reflected education or employment opportunities for parents, which alone or combined, may have increased net use. As noted earlier, the influential local missionary provided salaried employment and education opportunities for men of the more favoured church families, low paid cleaning work for their wives, and churches of all denominations were one of the few sources of salaried jobs, besides working away from the village at tourist camps. Families with church affiliation were more likely to adopt Westernized customs which may have included family net use.

6.3.4.2 Respiratory Infections

Relationships between climate and respiratory infections are not well understood, especially in SSA. Because acute respiratory infections (ARI) are caused by a large variety of microorganisms, there are a multiplicity of positive associations dependent on the specific pathogen including both dry and wet season, humidity, colder weather (in cool climates) and warmer weather (in some warm climates).[836] ARI risk is associated with indoor pollution,[837] which was relevant in Olkoroi where every home was heated with wood fire and had little ventilation. A Brazilian study of an equatorial city with little temperature variation (similar to the Narok region where temperature variation over the year was typically only 4-5 degrees), found RSV and influenza incidence highest in the rainy season.[838] Higher pneumonia mortality was correlated with rainy seasons in a Nairobi study.[839] In Olkoroi, children experienced significantly higher incidence of respiratory infections in the 3 highest rainfall periods, March-April, May-June, and November-December. There was a significant increase for adults only in the November-December period. No other variables were significant, possibly because respiratory infections had no known zoonotic element. Given the infectious nature of most common ARI and the village wide exposure to known risk factors, it may be less likely for SES markers to influence incidence. SES association might be plausible for progression to pneumonia, albeit frequency was too low to examine this potential relationship. Of the 12 infant mortalities over the past decade in Olkoroi, the 2 infectious disease deaths were both associated with respiratory infections.

As there was no diagnostic confirmation of illness, some illness presenting as ARI/colds could have been caused by other agents, including potentially zoonoses such as bovine tuberculosis. However, despite calls by both the WHO and FAO for epidemiological research to be conducted on zoonotic TB, very little work has been done and little is known about prevalence in livestock, humans, or variations that might exist in pastoralists and their herds versus other types of livestock keepers.[840] Some research indicates risks are higher in intensive production systems,[840] but testing done in Tanzania showed high variability in prevalence from one location to another.[841]

6.3.4.3 GI Illness

It was anticipated that OD and high density of livestock feces in Olkoroi might result in correlations between GI disease incidence and livestock-related or climate variables. The rainy season increased river height and water flow through the community, and almost certainly spread fecal matter more widely and into water sources. However, there was almost no associations with any of the variables used to model disease frequency. In children, HoH church attendance was associated with a significant reduction in infection frequency, possibly due to SES/behavioural habits as hypothesized for malarial risk. In adults the pastoral practice of moving livestock in the dry season was negatively associated with incidence. GI disease frequency was only 20% of malaria and ARI incidence, and the relatively low incidence may also have prevented detection of significant associations.

Despite the commonly asserted association of human diarrhea with livestock exposure routes in SSA,[736, 842-845] research results are mixed, and as with other diseases, there is a lack of quality evidence. A 2014 systematic review and meta-analysis of the association of diarrhea with domestic animal husbandry, reported 70% of included studies found a significant association between livestock exposure and diarrhea risk. However, only 23 studies of 5835 initially identified were eligible, on a scale of -2-8 the mean score of included studies was 3.5, only a third assessed temporal association, and most of research which met the review criteria focused on poultry.[845] Conversely, some studies suggest pastoralism and/or livestock ownership reduce diarrhea risk,[736, 763, 777] claims of association may be over-stated,[654, 843] and some research has demonstrated no association.[654, 736, 846] Tanzanian research in the mainly Maasai Ngorogoro region, found increased risk of childhood diarrhea associated with lack of formal maternal education, use of surface as opposed to tap water, failure to boil milk, and cooked food storage in traditional containers (calabashes).[828] All of these risk factors were widely prevalent in Olkoroi. A study in Kisumu of non-pastoral, peri-urban households[844] found no significant association with standard water, sanitation and hygiene (WASH) access/practice and diarrheal risk, but an increased risk associated with both animal ownership and the observed presence of animal waste in the household compound. Of note, however, was that the CI for ownership included one, and for waste was 1.01-1.89. A well-designed, well powered clustered RCT on WASH interventions in Western

Kenya found no impact on diarrhea prevalence, child growth, or child development.[847] Both studies were in communities where improved water sources and latrines were already available, and a Lancet commentary[848] suggested such interventions could have more impact in locations like Olkoroi where there are no latrines or improved water access.

If valid, livestock protective effects could be due to tolerance developed through routine exposure to pathogens commonly carried by livestock, and/or better nutritional status through the consumption of ASF. In Olkoroi, the lack of a rainfall association with increased risk could imply that exposure didn't increase sufficiently to change disease incidence during rainy seasons, or perhaps also that rainfall and higher, faster river levels cleared away accumulated waste reducing potential exposure. In the longitudinal study, some reports of GI infections included entire families and were said by participants to be from food contamination. It is also possibly that inoculation rates of disease agents from the general environment were not regularly high enough to induce symptomatic infection in a relatively resistant population, but the lack of safe food preservation and ambient temperatures conducive to bacterial growth made food a more likely route for disease causation when contamination occurred, as in the Arusha research.

6.3.4.4 Total Infectious Disease Incidence

Variable significantly correlated with total infectious disease incidence for children and adults were very similar to those for malaria, although the relationships were slightly weaker, likely because most common reported diseases were ARI and malaria, and the total associations with ARI were both smaller in number and weaker.

6.4 Conclusions and Recommendations

A substantial body of literature claims that livestock are a major source of disease in poor communities,[78, 79, 82] especially when, as for pastoralists, domesticated animals provide not just livelihood, but are a central part of identity and culture.[100, 158, 298] Some authors have taken this theme further, to claim that zoonoses are a barrier to progression out of poverty.[78, 79] Indeed, livestock will almost certainly be a potential source of illness for poor keepers. Some studies have shown that zoonotic disease burdens can be substantial under specific

combinations of conditions and types of livestock raised, for example poultry (associated with transmission of zoonotic diarrheal agents[846]) and pigs (associated with dangerous helminthic infections[842]). Zoonotic illness is also more likely to affect poor and/or traditional communities where infrastructure is weak for the same reasons the poor are more vulnerable to any type of infectious diseases. Nonetheless, there is substantial variation in livestock dependency, customary and livelihood practice, within pastoralist communities[298] never mind the global, livestock-dependent population. My findings in Olkoroi indicated the strongest correlates of human disease were with climate variations, as was also the case for livestock disease. I hypothesize that this was most likely a reflection of the effects of climate on vector populations, as the most common serious endemic diseases in the community were vector driven: in humans (omitting colds on the basis of their generally low pathogenicity), malaria, by a factor of five, the most common serious human disease; and trypanosomiasis, by a factor of two the most commonly reported livestock disease. Although the data collected was self-reported, and there are almost certainly widespread misdiagnoses and underdiagnoses of infectious disease in rural regions with inadequate medical and veterinary infrastructure, both community reported and clinical data suggest there are more important medical priorities for livestock keepers in Narok district specifically, and potentially across East Africa, than the current emphasis on livestock transmitted zoonotic infections. In combination with the insufficiency of evidence from the majority of low, and lower-middle income countries to support the breadth or certainty of claims that have been made about the importance of zoonoses,[9, 29, 79, 84, 85, 89, 91, 161, 269, 654, 736, 843, 846, 849], at minimum, a more coordinated and systematic approach to data collection on zoonoses is required to determine their actual contribution and relative impact on the wellbeing of livestock keepers. In particular, coordinated, systematic investigations over large areas, which consider ecological and cultural factors, and the specific livestock being raised, as well as a more consistent approach to investigation and analysis to allow comparisons across studies, would be more effective than the patchwork approach which predominates at present.[85, 736] In addition, more longitudinal studies are urgently needed to allow for both the calculation of incidence, and more reliable identification of risk factors associated with disease acquisition.

Before prioritizing zoonoses, it may be more appropriate to focus on what is already well known to contribute to infectious disease incidence and prevalence. The results of this research suggest that the following interventions, all of which are relevant to infectious morbidity and mortality risk in Olkoroi, would likely reduce frequency of all types of infectious disease, including zoonoses:

- delivery of public health information in a culturally effective manner
- an increase in medical resources including facilities, sufficiently trained professionals, diagnostic capacity, prophylactics and treatments
- provision of even basic WASH support
- exploration of traditional practices that increased infection vulnerability, and/or cultural resistance to protective measures like latrines
- more education opportunity for all ages and members of the population
- discussion of gendered practices that increase risk, often but not always for women, or create constraints to healthcare access for caregivers and their children.

Additionally, evidence is also required to clarify which health interventions are most needed. Inaccurate and inappropriate emphases on diseases that may not be significant risks in a particular area, are a poor use of limited resources, can undermine community confidence in medical professionals, and may distract from or obscure the need to address more basic, obvious needs such as reliable, clean water, and access to education and legal services, including enforcement of protective laws for rural women and men.

Pastoralists often have a greater degree of intimacy with their animals than other types of livestock keepers, as was seen in Olkoroi where it was the norm for families to keep young/sick animals inside their home, and livestock care was not generally viewed as associated with disease risk. Close contact with their animals, animal source food, and waste matter, is often presented as the primary infectious disease risk factor for pastoralists, and yet models constructed using a variety of herd and household sociodemographic characteristics, as well as livestock infectious disease prevalence, showed little significant association with human disease incidence in Olkoroi. The exception was the influence of church attendance

which may have been a reflection of education and financial advantages provided to those most closely connected to church hierarchy. This hypothesis was potentially supported by the fact that church attendance was significant for two disease categories where education and/or cost were more likely to be associated with preventative activity (the use of mosquito nets and sanitary practices). However, the relative uniformity of Olkoroi livelihood, lifestyle and cultural practice, may have obscured other possible SES associations.

Over three years of data collection, and many years visiting Kenya, I have repeatedly encountered condescension, bias, and lack of respect towards traditional Maasai, from medical, veterinary, social service and education professionals. In addition, the education, veterinary and medical district offices faced significant fiscal shortfalls relative to the large rural area they were assigned to serve. Such attitudes and financial barriers may have contributed to a failure to take local perception, values, practice and capacity into consideration in design and implementation of health interventions and service delivery. Research has repeatedly shown that lack of local input and contextual relevance can reduce effectiveness of interventions, may contribute to preventable disease incidence and prevalence, and may also lead to potentially harmful attitudes and beliefs.[850-854]

Gender in particular, seemed intertwined with almost every aspect of preventable morbidity and mortality of children and women. Adult mortality was not unusually high, but some female mortalities were potentially avoidable. Specifically, female deaths (and one simultaneous foetal death) occurred due to domestic violence (which also contributed to at least two known miscarriages), and lack of financial and/or physical autonomy to seek appropriate healthcare. Although the small number of mortalities and lack of confirmed cause of death reports precluded definitive conclusions about gender and mortality risk, it appeared that only one man died "prematurely" relative to his age, compared to potentially more than a third of the women.

Health-oriented education for women around preventative practices could have a multitude of benefits for family health in Olkoroi and similar traditional rural communities. Reinforcement and integration of preventative activities with local culture could improve on existing practices, as well as potentially halt ongoing preventable mortalities, for example from anthrax. For optimal reduction in morbidity and mortality, however, health education is

required for both men and women since men are a component of the barriers to improvement in the health of Olkoroi women and children, as in many parts of rural SSA.[855] Wellbeing interviews in Olkoroi indicated both men and women placed a high value on children (4.2.5), as is the norm in Maasai culture. Education on early warning signs of high risk illness in children, for both men and women, might increase the capacity of women to react more quickly to potentially serious illness in children, but also, by enabling men to also recognize warning signs of more serious disease, for example respiratory infection, increase the likelihood of gaining necessary male HoH support to follow up with appropriate medical intervention. Since published research also suggests that women may obtain healthcare for themselves when care seeking for children,[809] more effective healthcare for children could simultaneously enhance maternal health. Recognition of adult early warning signs would benefit men as autonomous decisions makers about care-seeking, but potentially some women through reduced delays in accessing care.

The strength and validity of the conclusions drawn from these studies may be limited due to the size of the community, relatively uniform lifestyle and exposures, custom and belief, and the reliance on self-reported illness without diagnostic confirmation. However, repeated acknowledgement of the lack of adequate surveillance, lack of data, and several recent systematic reviews on exposure-risk relationships in SSA, make it unequivocal that some claims about the livestock-associated disease burdens of pastoral and rural livestock-dependent SSA communities are insufficiently supported by evidence.[29, 79, 84, 85, 654, 764] Although numerous studies have been conducted throughout SSA, associations have rarely been causally explicated, whether they be positive assertions about the benefits of livestock-based livelihoods, or potential threats. A systematic review of human-livestock zoonoses transmission risks, concluded little is known about the determinants of transmission, especially for keepers, and least of all in developing countries.[856] Furthermore, typical pastoral animals may not carry high threat pathogens, and a small number of studies indicate null or protective associations against diarrheal diseases with livestock-keeping. To date, small ruminants, critical assets for funding day to day expenditures, and livelihood building blocks for poor pastoralists, have been neglected from a research perspective. Another small body of research implies goats may be an almost ignored source of zoonoses, in some

studies, more important than cattle. Although there is still insufficient prevalence data on both human and livestock disease across much of rural Africa, the pressing need for well-designed causal studies does not preclude simultaneous expansion of the database on prevalence and incidence. With limited resources, and a low likelihood of significant expansion of health infrastructure into rural regions in the near future, the most effective way to reduce morbidity and mortality is to ensure that available resources are targeted to prevention and treatment of the highest risk diseases identified by evidence not hypothesis and extrapolation, and in the most cost-effective manner. However, without careful consideration of the effects of gender on autonomy, customary beliefs and local behavioural motivations, intervention campaigns cannot be optimally successful.

Chapter 7: Summary, Relevance, Recommendations and Conclusion

7.1 Summary of Findings

The review in Chapter one revealed that, although much has been written on the influence of livestock ownership and livestock health on the wealth, psychological wellbeing and health of traditional Maasai pastoralists, evidence is scare and conclusions are primarily based on theory, extrapolation or at best, cross-sectional surveys, with very few longitudinal investigations. In addition, where outcome data are collected, wellbeing is most frequently measured in economic terms, at the household level, with little consideration of gender. A similar pattern was observed in a survey of more than 1500 articles extracted from Medline on livestock-based interventions to improve human wealth/health status in poor livestock keeping communities. Although the literature consistently describes a positive association between improved livestock health and productivity and human wealth and/or health, the survey found only 16 publications (1%) concretely measured outcomes from interventions, only nine studies specifically examined human health variables, and only one study explored the influence of gender. A 2019 gap analysis on pastoral sustainability found very similar results, with only 1% of 2658 publications referencing gender.

A single community study may raise concerns about generalizability, but collected data combined with over a decade of ethnographic observations (associated with community development initiatives conducted since 2003 from Olkoroi and surrounds), provided not only relevant context for this thesis, but also enabled comparisons with other published research. Two years of Olkoroi clinic data and a year of Narok district health data were also obtained as a point of comparison with community self-reported health. In all known aspects, from customary practice, traditions, gender roles, diet, and livelihood, to past and current educational attainment, livestock holdings, and disease frequency in livestock and humans, Olkoroi exhibited characteristics, and had experienced challenges and social pressures very similar to neighbouring settlements, district communities, and Maasailand in general (both Kenya and Tanzania), as documented in the large body of existing literature. The extensive sociodemographic, and cultural information collected, summarized and discussed descriptively in chapters three and four were the source of variables used in building models

to explore and understand the factors which affected wealth, life satisfaction, herd size, young livestock growth, and livestock and human health in chapters four through six.

Cluster analysis of wealth markers reported in chapter four, suggested livestock ownership remains one of the most effective rapid wealth assessment tools to delineate traditional pastoral communities, likely because of relative uniformity in other indicators commonly used in wealth research such as housing, material goods, and education attainment. There were, however, some critical sex differences. In particular, women were more likely to be lone HoH, and less likely to own livestock or land primarily due to customary law. Average SWLS rating was almost exactly the same for men (22.8) and women (22.3), interpreted as average or neutral wellbeing. However, mean wellbeing obscured the significantly different proportions of men versus women in the average and above average categories. Twice as many men self-rated as satisfied versus neutral, while women were 1.4 times more likely to feel neutral life satisfaction versus satisfied/very satisfied. Part of the differences appeared to be marriage. Women were more likely than men to identify children as positive contributors to current wellbeing, and marriage as a detractor (only one man perceive marriage as a negative). Furthermore, 25% of women (and again only one man), were concerned about marital conflict as a future wellbeing detractor. In a multivariate model to predict wellbeing, number of livestock owned, being a teetotaler, position as HoH, and larger family size were all associated with higher life satisfaction.

Chapters five and six examined various dimensions of livestock and human health, including perspectives on the contribution of livestock to wellbeing, livestock and human disease prioritization and understanding, self-assessment of livestock keeping skills and constraints on livestock productivity. Further models were constructed to identify variables associated with herd size, young livestock growth, human and livestock disease rates. Livestock were universally viewed as a positive contributor to wellbeing, but few residents agreed that livestock could have a negative impact, though a small proportion of respondents noted livestock keeping was physically demanding. Droughts were further observed to cause a substantial increase in labour requirements and livelihood risks. As both pastoralists and academics perceive drought frequency is increasing,[857] and GCC is predicted to cause further disruptions, drought concerns were highly relevant. Community perceptions about livestock

disease were similar to those found in other studies, in both disease prioritization and rationales for prioritization, and, as has also been reported elsewhere, understanding of disease causation and options for treatment was low, particularly in women. Although there was no similar human disease prioritization work found, community prioritizations were similar to the most common diseases reported locally and at the district level, although the community ranked some human diseases disproportionately to their reported frequency over the research period, specifically brucellosis and HIV, possibly because of attention brought to bear by major public health campaigns.

Most HoH self-rated their livestock husbandry positively. In open-ended discussion of pastoral livestock practice, herding, disease treatment, and acquisition of crossbreeds were identified as most important to maximize productivity. Herding and treatment were also self-perceived to be the two best performed tasks. However, herding and improvement of breed quality were also among the most commonly identified worst practices. When asked about rationale for choices of worst husbandry practices, more than 75% of respondents across all selected worst-practices stated they could not afford better practice. In the context of human diseases, common preventatives appeared to be known but inconsistently practiced. Conversely, livestock diseases prophylaxis was more likely to be over-used or ineffectively practiced in a manner likely to contribute to pharmaceutical resistance.

Herd size predictive models identified significant variables similar to those reported in previous research, including diversification, family size and land ownership, but the contribution of family size was small. Marital status was the most strongly associated with size of livestock holdings, in part because single HoH were predominantly women who rarely owned livestock. The only household variable significant in the young livestock growth rate model was family size. The size of the coefficient was unexpectedly very small and negative, possibly a spurious association or a reflection of changing livestock responsibilities as more children have the opportunity to pursue formal education. The absence of other SES factors may have been due to the high infectious disease morbidity and mortality rates that affected community goat/sheep holdings, including major drought effects, and the relatively small number of available young cattle for measurement. Other significant

variables were as anticipated: larger animals (cattle and sheep) grew more rapidly than goats, and all animals grew more slowly during the drought.

Exploratory livestock disease prevalence models found almost no association between total (all disease reported each interval) small ruminant disease and any household, livestock or climate variables. It seems plausible that very high year-round infectious disease morbidity and mortality rates in small ruminants made it impossible to discern the effects, if any, of specific herd, HoH, or climate variables because of the ubiquity of disease agents. Goats and sheep were also valued less, both in a monetary and cultural sense, relative to cattle, reflected in lower frequency of treatment, vaccination and quality of herding (often delegated to young children). However, drought significantly reduced the frequency of olodua (the most common small ruminant illness), total reported cattle disease, and trypanosomiasis, the highest burden cattle illness. The drought effect was most likely due to reduction in vector populations (responsible for 50% of the total reported disease prevalence) and water borne dissemination of disease agents. In addition, wealthier families moved their livestock from the community when the drought occurred so animal contact was reduced. There were also some associations between olodua prevalence and normal precipitation variation through the year (higher in and following rainy months, lower in drier months) but little seasonal associations with cattle disease, total or trypanosomiasis. The differences between small ruminant and cattle seasonal associations may reflect differences in diseases and transmission routes for the two types of livestock (cattle, for example, rarely suffered diarrhea). Trypanosomiasis, which made up almost 50% of the cattle disease reports, was reported throughout the year with little variation, and described as endemic by a number of respondents. Although the literature suggests some climate effects on the tsetse vector, the location of Olkoroi, surrounded by forested hills, and with a reliable water supply, may have, as respondents claimed, allowed the tsetse fly to persist year round-except in the drought.

Two HoH variables were associated with decreased olodua prevalence, greater HoH diversification and herd size, both of which are widely correlated with increased income in pastoral literature. Higher income may allow better quality care such as vaccines, more prompt and/or more effective treatment: some poorer households were witnessed to delay disease treatment. For cattle, church attendance and current HoH marriage were associated

with decreased disease frequency. Churchgoers may have experienced advantage for reasons similar those known for diversification, as some church goers received major income/diversification opportunity from missionary. Intact marriages may have provided more household stability, herding capacity and efficacy.

As with livestock disease models, human diseases were predominantly associated with seasonality and drought. Higher rainfall periods were associated with greater disease frequency in children, with the exception of GI illnesses. Church attendance was associated with decreased risk for malaria and GI, possibly due to better uptake of preventative practice and resources. In adults, only rainfall had an impact on diseases frequency, although lower GI frequency was associated with migration of livestock away from the village.

Overall results from the livestock disease models were similar to previous studies, suggesting biome, climate, and family capital were the strongest correlates with disease prevalence. Animal disease models, especially cattle, were possibly confounded by the drought, subsequent depressed fertility, and the relatively low community cattle ownership compared to small ruminants. Models of human disease were most interesting for what was not a significant predictor, livestock disease, but the importance of climate was unsurprising given the two most common diseases were “colds” and malaria (98% of reported incidence). Prevalence of the mosquito malaria vector is well known to be affected by rainfall and temperature, and respiratory infections are globally associated with colder, wetter weather. GI illness is more likely to be livestock related, but the ubiquitous presence of animals and their by-products may have created a relatively uniform, year-round community exposure even for those without animals, and prevented identification of associations with specific livestock or household variables.

7.2 Strengths and Unique Contributions

The research described in this thesis has several significant strengths, specifically: the use of mixed methods research, including participatory methodology, which facilitated a multidimensional exploration of health, triangulation of some key outcomes and relationships, and an understanding of potential motivations for community behaviours affecting livestock and human health; the examination of human wellbeing from three

different perspectives, material wealth, psychological wellbeing, and disease incidence; consideration of the impact of gender throughout; and simultaneous, longitudinal collection of data on both livestock and human disease to allow more effective assessment of the influence of livestock disease on human infectious morbidity.

A number of unique contributions and questions about current representation and understanding of the role of livestock in the wealth, psychological and physical wellbeing of modern, albeit traditional pastoralist, rural Maasai emerged from my research. The sociodemographic data indicated single adult households made up a significant proportion of the community (35%), and were primarily headed by women (85%). Single HoH (male and female) were least likely to own livestock. Since livestock were the primary wealth indicator, the variable most strongly associated with psychological wellbeing, and the asset most likely to be used for diversification, the livestock-poor were multi-dimensionally vulnerable. The frequency of solo HoH was possibly increasing due to breakdown of cultural safety nets in combination with gendered household dynamics, as well as conflict between traditional values and the influence of external forces including education, growing familiarity with national law, diversification pressure, private land ownership, and the incursion of Christianity. Female HoH, routes by which solo households occur, prevalence trends, and specific vulnerabilities of these households, do not appear to have been significantly reported on in the academic literature about the Maasai. Despite their absence from published research, these households made up a distinct proportion of the Olkoroi community, frequently included children, and rarely had any opportunity for livestock acquisition and/or diversification, in large part because of traditional gender roles and tribal laws. Children from poor households were further unlikely to be able to access education beyond primary school in Kenya's fee-based secondary school system. As formal education appears to be increasingly a route for non-livestock based diversification opportunity,[108] single adult households may be an initiation point for generational poverty. Although based on a very small pool of data, women seemed also more likely to experience premature mortality, potentially related to lack of autonomy and resources required for effective diagnoses and treatment. If the prevalence of single HoH is similar or increasing in other rural Maasai

communities, such families represent a high priority vulnerable subgroup for livelihood research.

The life satisfaction study described in chapter 4 was only the second such study with a Maasai population and some of the results contradicted previous research.[185] Specifically, I found substantially lower satisfaction in both men and women than reported in an earlier Maasai SWLS study, and men were significantly more likely than women to self-rate as satisfied versus neutral with the lives. Globally, most wellbeing research finds women to be happier than men. The addition of a qualitative inquiry into self-identified contributors or detractors from life satisfaction generated both expected and unique findings. The association of increased household livestock holdings with increased happiness in both sexes, parallels a large body of research which shows that until basic needs are met, increased income is strongly associated with increased life satisfaction. Olkoroi men and women, however, differenced in their perceptions about the contribution of family and marriage to life satisfaction. Very similar proportions of men and women expected children to be significant contributors to future life satisfaction, but women were more than twice as likely to see children as current contributors to their happiness. In addition, 25 and 21% of women viewed marriage as a detractor from current and potential future life satisfaction, respectively, while only one male respondent felt marriage had reduced his current life satisfaction. Gendered difference in life satisfaction were almost certainly associated with cultural traditions and tribal law as indicated by female elaboration on their choice of positive and negative impacts on their psychological wellbeing. The findings of positive associations of both livestock holdings and family size with psychological wellbeing were similar to existing wealth research, but the association of position as household decision maker with higher life satisfaction in a Maasai community adds to global research indicating autonomy is an important dimension of personal life satisfaction. A recent review of gender and intersectionality in GCC literature concluded that most research does not go beyond simple comparisons of male and female perspectives, omitting the necessary exploration of "…power relations determining access to resources, information and the availability of options and choices,"[679] a quote which applies equally to research in livestock dependent

communities.[61] These issues were brought to the fore by a number of women in the wellbeing interviews, particularly as regards decision-making and control over livestock.

Although a number of studies have been conducted in which Maasai communities have been asked to prioritize livestock diseases, as far as could be determined, there was much less comparable human disease work. This made the investigation into community prioritization and perceptions regarding human illness, reported in chapter 6, an important contribution. In combination with the findings that livestock disease did not appear to be significantly correlated with human disease, these findings potentially signal a need to listen more closely to the Maasai, and pastoralists in general. As was already known, in direct contradiction to the overwhelming academic emphasis on zoonoses as mediators of human poverty, morbidity and mortality, pastoralists do not generally prioritize, or in some cases, even recognize zoonoses. At minimum, an inconsistency of disease prevention practices in combination with major gaps in local understanding/acknowledgement of routes of infectious disease transmission, including for the two most recognized zoonotic diseases in Olkoroi, anthrax and brucellosis, suggest public health campaigns have not successfully overcome information poverty and strongly held traditional beliefs. On a related note, a variety of observations, interviews and descriptive data relating to livestock disease management, demonstrated that, at least in Olkoroi and surrounding communities, programs and measures intended to compensate for the collapse of Kenya's public veterinary system, have been at best, unsuccessful and at worst dangerous (in that they have led to unmonitored use and misuse of pharmaceuticals), despite publications which have claimed efficacy for community animal health workers and other alternative modes of information dissemination.

The final unique contribution of this thesis was the collection of longitudinal data on livestock and human disease concurrently and use of this data to explore the contribution of livestock disease to human disease incidence. The primary influences on disease in children and adults were seasonal, including drought effects, both of which were most likely related to rainfall. SES variables appeared to have little impact on disease risk in adults, but church attendance was associated with lower risk of malaria and GI disease in children, possibly due to information dissemination to HoH, and changing cultural practices promoted by area churches. Livestock disease prevalence was not found to be associated with human disease

incidence, which directly contradicted an almost universal academic paradigm about relationships between livestock and human disease in poor livestock keeping communities.

7.3 Limitations

There were six primary limitations on the studies making up this thesis. Firstly, data was collected from a single community with a relatively small sample size ("n" of 500). This limits generalizability, but there was some evidence to suggest that Olkoroi was typical of many rural Maasai communities. Specifically, households were similar in composition and cultural traditions, had experienced similar life trajectories and challenges, and undergone livelihood adaptions similar to those described in work by numerous Maasai-focused academics[1, 108, 163, 226, 229, 330, 331, 371, 403, 412, 747, 858]. However, two local features made Olkoroi somewhat different, even to very nearby Maasai communities: the presence of a year-around water source and the periodic residency of an American missionary in the community for more than twenty years. The local water source made crop production much more feasible than in many arid and semi-arid land regions and decreased malnutrition risks for those with capacity and access to arable land, although it did not prevent crop failure and serious livestock mortality during extended droughts. While water availability affected all community members similarly, local church influence, and particularly benefits from the missionary, were available only to favoured associates. Although Christian evangelism is widespread through Maasailand, advantages of church affiliation in Olkoroi depended on sex, type of affiliation, and presence of church representatives (church activity was much lower when the missionary and other church leaders were absent) and may have affected generalizability of results. Church association was significant associated with some disease categories in both livestock and human health models, and was very close to significant in predicting livestock holdings. Nonetheless, neither the presence of a missionary and/or church influence,[403, 859] nor a reliable water source were exceptional.

Secondly, the majority of the female residents could only speak Ma, the men, Ma and Swahili, and I had fluency in neither language. Consequently, I was almost completely dependent on local assistants, although most of the work was done by a single community member, Ole Koshal. Although some of the survey and interview instruments had been used successfully and/or validated in other settings, tools developed for this research were pre-

tested in both Olkoroi and surrounding communities, interview questions back translated, and interview responses triangulated via translation by different local assistants, there was still a language barrier between myself and the community. As almost all of my primary and temporary research assistants, were male, it is possible women were reticent to speak openly. On the other hand, extensive amounts of time were spent with many women in Olkoroi and surrounding communities, and the spontaneous discussion and self-reports of significantly intimate information (ranging from emotional and psychological distress, spousal violence, and reproductive challenges), suggested that women were very comfortable with Ole Koshal. On a related note, there were no local residents with higher than secondary graduation, and most adults had received no formal education. This created some difficulties and early data loss due to a combination of low scientific literacy in community assistants, and inexperience on my own part in field management in such a community. For example, the first year of human health data had to be discarded as it excluded some households, and most children.

Thirdly, most of the data collected from the community was based on self-reports. Morbidity and mortality reports collected in the longitudinal health surveys in both human and livestock were not confirmed with laboratory follow-up, and identity of ongoing illnesses occasionally shifted in following weeks. Disease assessments made by the local health clinic and subsequently self-reported, were also usually presumptive, based on symptomology, and some of the most common illnesses reported had symptomatic overlap. Consequently, there was a high probability of misidentification and misdiagnosis. In addition, some community members reported both livestock and human morbidities and mortalities repeatedly which may have resulted in an over-estimate of disease frequency. Resource limitations prevented individual livestock monitoring, and therefore only prevalence measures could be made. For human disease, household members were tracked individually, and close comparisons were made of reports from one data collection to the next, to differentiate ongoing disease from new cases. However, the nature of self-reported data in a low-resource community made it likely that incidence data may have occasionally included prevalent cases.

Fourthly, although the community was predominantly settled, livestock movements were still common, and particularly in drought periods, herd sizes dropped significantly in a number of households, leaving continuity gaps in modelling livestock-human health

connections. Families also generally took their livestock to extended family rather than migrating as groups, so livestock exposures during drought periods were not uniform, dependent on distance travelled and the location to which animals were taken. The period of time that animals were absent was also highly variable from days to months.

Fifthly, the fact that I was engaged in community development efforts with the local primary school and women in Olkoroi and surrounding communities could potentially have affected responses of interviewees for questions which had social and psychological dimensions. In particular they could have resulted in exaggeration of disease status in both the human and livestock surveys. However, the development work had been well-established prior to the initiation of academic research, and continued during and following the completion of data collection, families regularly reported no illness in herds/flocks/household members (suggesting false reporting was limited if it occurred at all), and Ole Koshal was highly experienced with livestock, and routinely visually confirmed the state of livestock reported as sick by HoH. In addition, there were no easily accessible veterinary support available, so there was no obvious benefit to exaggerating morbidity of animals.

Lastly, the time period between initial data collection and completion of the thesis was a decade. The Maasai in Olkoroi and elsewhere, like all communities, continue to adjust to changing internal and external influences at the local, tribal, national and international level. These include but are not limited to, changes in political, developmental, agricultural and scientific paradigms, globalization, and/or cultural shifts. Climate variability remains highly relevant, most importantly drought frequency and duration, which with anticipated GCC could bring substantial additional challenges in the future. However, based on going communication with members of the community, it is very apparent that the primary struggles faced by the community from 2008-2010 have changed little, if at all. Educational opportunities, especially secondary and post-secondary, remain limited for the children of the still predominantly illiterate adults of the community. Latrines are still absent, and the same endemic human and livestock illnesses persist. The challenge of maintaining adequate teaching staff at the local primary school continues, and schoolgirl pregnancies remain frequent, even in primary school students. Infrastructural limitations continue to cause unnecessary morbidity and mortality in both human and livestock populations, and traditional

values hold strong. Information poverty regarding disease etiology and treatment mechanisms in combination with almost absent veterinary infrastructure, continues to promote inappropriate treatment practice, creating ongoing selective pressure for development of resistance to a variety of widely used pharmaceuticals

Despite the noted limitations, many of my findings paralleled characteristics and associations reported in related research.

7.4 Future Research

There are a number of future research paths suggested by my findings. Although gender has been a focus for crop-based research for some decades, and there has been some attention paid recently to women's perspectives in livestock keeping, gender must be incorporated more routinely into pastoral studies. This applies especially to research carried out with Maasai communities. Given the quantity of research that has been and continues to be conducted on the Maasai and their livestock, the relative paucity of female perspectives and experiences is a deficit. It is well known that Maasai women subject to tribal law cannot inherit land or livestock, and it is culturally represented that marriage breakdown is rare.[392] However, the reality of married life in Olkoroi indicated a significant proportion of women were de jure or de facto HoH, and many lacked sufficient assets to support their families. More importantly, opportunities for livestock acquisition and diversification, generally challenging for poor HoH, appeared to be extremely low for women. Some intact families were poor, but these types of households have been fairly well documented. Single parent Maasai households (mostly FHH, but there were a few solo MHH in Olkoroi) are rarely reported on in the literature beyond comments about difficulties women have in accessing livestock and livestock-related resources. As single adult households are often multiply vulnerable, they should be prioritized in future poverty-related research and discussion. It was also clear from information collected in Olkoroi that typical material measures of wealth did not capture all dimensions of wellbeing, especially for women. A full representation of household wellbeing must be both gendered and include non-material wellbeing assessment. Although not a focus for this research, there were families in Olkoroi where unmarried, young adult men had taken on provision for the household even though their father was still

ostensibly present, because of paternal neglect. These young men were frustrated that the burdens they took on were constraining their own advancement and also that traditional custom gave them no jurisdiction over family livestock holdings. This frustration was reflected in their presence in the lowest category of life satisfaction along with very abused and/or neglected women. Although there has been more research focused on young Maasai than on single HoH, this too is an important demographic for livelihood research. Social shifts that affect the opportunities and life trajectories of new generations, including tribal customs associated with decision making, livestock keeping and inheritance, overlap somewhat with those that affect and constrain women. In particular, at least one study has suggested lack of opportunity is slowing the transition from youth to adult status in some communities, which in turn threatens the traditional fabric of Maasai culture.[550]

It is natural to focus on livestock disease in pastoral research, but the relative proportion of livestock versus human health work must be reviewed, and the perspectives and genuine participatory involvement of research communities prioritized. Some evidence has suggested a greater willingness to pay for livestock than human health preventatives.[14] This may be superficially true, but the research on vaccine uptakes suggest there is more nuance at play than "willingness to pay". Claims for a major role of zoonoses in poverty, morbidity and mortality of livestock-keeping communities have been made repeatedly, but the evidence to support these claims, or at minimum, the extent to which they have been generalized, is relatively weak. In addition, some studies indicate that livestock ownership is predictive of higher health status, decreased morbidity and/or higher disease resistance, and greater household resilience. These claims need not be mutually exclusive, but regardless, more direct exploration of both livestock and human disease simultaneously is necessary so that claims can be confirmed, refuted, or clarified. In particular, it is critically important that more longitudinal studies are conducted in which both human and livestock health are followed, disease incidence is measured, and in ASAL regions, data is collected long enough to cover multiple seasons and drought periods as both appeared to play a major role in disease frequency in Olkoroi. Ideally such studies should have laboratory confirmation of disease reports. In Olkoroi, as has been reported elsewhere, there was confusion over terminology, diseases with overlapping symptoms, and significant lack of understanding

about causation and appropriate treatments for both human and livestock diseases. If indeed seasonality, climate and geography are the predominant drivers of disease, more work is required which focuses on how to counteract the impacts of these fixed contributors to diseases burdens.

Another neglected facet of pastoral research is small ruminants. It is often stated that small stock are important assets in covering day to day household expenses, smoothing out expenditure "shocks", and also that they are critical "ladders" out of poverty because of their low cost, and fertility. Goats and sheep are fundamentally more flexible assets, especially for vulnerable households, and the overwhelming majority of small ruminants are reared in smallholdings.[681] Despite their importance, morbidity and mortality rates remain unacceptably high.[686] It is not enough to speak about their importance, investigations into all aspects of small ruminant diseases must be prioritized.

Lastly, a variety of factors including information poverty, resource availability, education, cultural practice and beliefs, gender roles, and household level cost-benefit analyses appeared to not only be limiting the adoption of best practice for human and livestock health and effectiveness of veterinary and human public health campaigns, but also potentially creating new health risks. Illiteracy and low educational attainment in Olkoroi prevented full/effective use of available information and resources and caused potentially dangerous misuse of veterinary pharmaceuticals. Throughout the long writing of this thesis, I continued to receive communiques from Olkoroi querying livestock disease causation and describing continuation of problematic practice observed during data collection, including persistent cycling of available treatments regardless of disease and use of antibiotics for viral disease. Cultural practices and beliefs perpetuated ongoing high risk behaviours such as consumption of contaminated food including livestock which had died from zoonoses, and resistance to information on disease transmission pathways, for example Brucellosis and fecally transmitted diseases. Deaths from anthrax occurred as recently as 2016 despite widespread theoretical awareness of its zoonotic capacity indicated by data collected in 2009. Many women, overwhelmingly responsible for children, meal preparation, and home-related tasks, as well as increasing responsibility for livestock with children in school, were familiar with safe practices for treatment of water, milk, and use of mosquito nets, and yet, did not

follow preventative practices consistently. Women were also intimately familiar with some of the potentially most negative consequences of traditional practices associated with early marriage for girls (and consequent constraints on educational opportunity). Some mothers wanted a different future for their daughters, and yet had limited capacity to protect them because of gendered tribal tradition and law associated with livestock ownership, the primary form of community wealth.

In combination these locally relevant gaps very likely increased human and livestock disease, and decreased livelihood returns. Although some regional professionals spoke disparagingly about the "ignorance" of the Maasai, community behaviours appeared to be driven by complex but sometimes contextually logical, interacting and intersecting motivations, as has been shown to be the case globally, where information is available. Although research into barriers to best livestock-rearing practice is relatively limited regardless of geographical focus, a 2018 review and synthesis of global research on livestock-related water conservation practices concluded, as in Olkoroi, that sociodemographic factors were less important than access to reliable information, and cost-related factors such as availability of government subsidies and profit impacts. More complex and difficult to measure factors such as social norms also appear to play a role, again, very relevant to traditional pastoral communities.[860] Understanding behavioural motivations is important in providing best support for any agricultural initiatives, but given the high levels of infectious disease, concerns about zoonoses, and elevated child and maternal mortality associated with pastoralism, and likely many rural, livestock-dependent communities in the Global South, it is critical to ensure that health information, resources, and interventions are appropriate to target communities, and provide maximal benefit and minimal harm. Fundamentally, there is insufficient research being conducted to understand barriers and/or resistance to adoption of best practices for livestock and human health. If barriers and/or resistance can be explicated, the development of more effective, acceptable, feasible and accessible control options may be possible.

7.5 Conclusion

Much has been written about poor livestock keepers, pastoralists included, but in many rural regions, little has changed over several decades. In some cases, circumstances for rural, livestock keeping communities have become significantly worse. At the same time, pastoralists specifically, continue to be robust contributors to livestock trade and economy.

In the first few decades of the 21st century, new approaches such as One Health and Ecosystem Health have been adopted as methodological answers to solving some of the most intransigent and intertwined human and livestock health/poverty constraints. Unfortunately, although it has been repeatedly acknowledged that livestock-based poverty alleviation interventions had few successes in the last century, the more recent academic approaches do not seem to have been very effective either. A 2017 systematic review examining the effectiveness of One Health research concluded, as in my own survey and related reviews that One Health research was generally failing to measure quantitative outcomes (only seven of 1939 reviewed papers). Of equal, if not more concern is that some publications made assumptions about the effectiveness of One Health initiatives without evidence. The authors further observed, that "disease incidence and prevalence in either animals or people do not indicate the severity and distribution of a disease," an observation which holds true for a large proportion of the cross-section research on zoonotic disease across Africa.[60] One Health leaders have started some very necessary conversations asking why there has been such a failure of research to affect the day to day experiences of poor livestock keepers. In a 2017 discussion paper by Bardosh, Delia Grace said, "One Health…hasn't and isn't making a big difference in the 'real world'.[45] However, the Bardosh discussion and others [722] have been taking place firmly rooted in the premise that zoonoses are critical constraints to the improvement of health and wellbeing of the livestock dependent global poor. They may be; zoonoses are well known to be highly important in emergent disease, and there is substantial evidence that endemic zoonoses are prevalent and potentially important to varying degrees in many poor and/or traditional livestock-keeping communities.[14] However, despite a dramatic increase in the amount of zoonoses research in the past decade,[28] a recent systematic review of zoonoses research in Africa concluded there was not yet sufficient quality information to guide effective interventions or policy,[83] a conclusion echoed by several other recent

systematic reviews [85, 736, 845, 856, 861] At least one author has suggested that One Health focus on zoonoses is related to the desire to make the poverty discussion manageable, by limiting the number of relevant factors under consideration as well as focusing on relatively easily measured indicators.[862] Other explanations relate to the priorities of research funders.[45]

Nonetheless, within the One Health discussions about lack of progress and continued insistence that zoonoses are the key to poverty reduction, is acknowledgement of the deeper roots of persistent, and in some cases, worsening poverty and health difficulties of livestock keepers. "In the case of zoonoses, it is clear that risk factors for exposure are influenced by a vast array of ecosystem factors, animal and human behaviours and political economy dynamics".[45] I would modify this claim by removing zoonoses from the statement, and simply replace "risk factors for exposure", with "risks for poverty and ill health".

While this perspective is not mainstream, Kingsley, in an exploration of diverse and divergent perspectives on what One Health has been, and should be, described a type of One Health research, which has "…an excessively narrow approach that focusses on defending against particular zoonotic threats." In worst case scenario this perspective, "privilege[s] a scientific and Western-centric concern with pathogenic contamination".[863] I do not claim that zoonoses are not important. However, my observations, research and analyses of data collected in Olkoroi, lead me to believe that other factors, or perhaps deficiencies, are more important in preventing broad human health improvement in rural livestock keepers, such as basic medical, veterinary, education, sanitation, and technological infrastructure. Livestock disease is obviously important in livestock-dependent livelihoods and zoonoses can add to general burdens of poverty and health vulnerability. But in Olkoroi, though livestock disease was directly important in its impact on the family "bank" balance, it was not associated with increased risk of the most commonly reported human diseases. To the contrary, it was the greater, uncontrollable force of climate, especially regular, possibly increasing droughts which had the biggest effect on the frequency of most livestock and human disease. GCC is already affecting disease distribution, and a small amount of research on gender and GCC, indicate that women may be most vulnerable to negative climate change effects. Even here, though, most claims appear to be theoretical rather than evidence based.[679]

Large scale infrastructure improvement requires political resources, involvement and commitment at the national level. Realistically poor communities in most LMIC are unlikely to receive necessary infrastructure "upgrades" in the near future. The question becomes: what can be done in the interim? There are no easy solutions, however, one of the most basic necessities is to let livestock keepers speak for themselves, listen to what they say, and collaboratively develop feasible and sustainable intervention focused on community priorities. The people who live in an ecosystem understand it the best, and those who live the consequence of climate, disease and poverty should be the decision makers about intervention priorities. In addition to collaborating with livestock keepers in a meaningful manner, researchers need to work collaboratively with each other, so that critical missing information about zoonoses prevalence, incidence, consequence, and if a priority, contextually appropriate control measures can be identified. Limited resources, especially in LMIC need to target diseases that are relevant, and that can only be done effectively with good quality evidence obtained from well-designed studies. One Health, because of its combined focus on both human and livestock health, in combination with Eco-Health methodology for its emphasis on participatory interdisciplinary research and careful consideration of SES and human health-ecosystem interactions, are in principle ideal for such studies. However, it is imperative that we acknowledge the documented flaws in methodological approaches and develop a more authentically collaborative approach to improve the practical benefits of research, and efficacy of interventions.

References

1. Hughes L. Moving the Maasai : a colonial misadventure. Houndmills, Basingstoke, Hampshire ; New York: Palgrave Macmillan in association with St. Antony's College, Oxford; 2006. xvii, 238 p. p.
2. Olinto P, Beegle K, Sobrado C, Uematsu H. The State of the Poor: Where Are The Poor, Where Is Extreme Poverty Harder to End, and What Is the Current Profile of the World's Poor? : World Bank; 2013 October 2013. Contract No.: 125.
3. Scoones I. Sustainable livelihoods and rural development: Practical Action Publishing; 2015.
4. Narrod C, Tiongco M, Scott R. Current and predicted trends in the production, consumption and trade of live animals and their products. Rev sci tech Off int Epiz. 2011;30(1):31-49.
5. Herrero M, Havlik P, McIntire J, Palazzo A, Valin H. African Livestock Futures: Realizing the potential of livestock for food security, poverty reduction and the environment in Sub-Saharan Africa. 2014.
6. Pica-Ciamarra U, Tasciotti L, Otte J, Zezza A. Livestock in the Household Economy: Cross-Country Evidence from Microeconomic Data. Development policy review. 2015;33(1):61-81.
7. Dror DK, Allen LH. The importance of milk and other animal-source foods for children in low-income countries. Food & Nutrition Bulletin. 2011;32(3):227-43.
8. Thornton PK. Livestock production: recent trends, future prospects. Philosophical Transactions of the Royal Society of London B: Biological Sciences. 2010;365(1554):2853-67.
9. Randolph TF, Schelling E, Grace D, Nicholson CF, Leroy JL, Cole DC, et al. Invited Review: Role of livestock in human nutrition and health for poverty reduction in developing countries. Journal of animal science. 2007;85(11):2788-800.
10. Upton M, Otte J. Pro-poor livestock policies: which poor to target. Rome, Italy: FAO. 2004.
11. Gabriël S, Dorny P, Mwape K, Trevisan C, Braae UC, Magnussen P, et al. Control of Taenia solium taeniasis/cysticercosis: the best way forward for sub-Saharan Africa? Acta tropica. 2017;165:252-60.
12. Catley A, Lind J, Scoones I. Pastoralism and development in Africa: dynamic change at the margins: Routledge; 2013.
13. Devereux S, Scoones I. The crisis of pastoralism? 2008.
14. Grace D, Lindahl J, Wanyoike F, Bett B, Randolph T, Rich KM. Poor livestock keepers: ecosystem–poverty–health interactions. Phil Trans R Soc B. 2017;372(1725):20160166.
15. Halliday JE, Hampson K, Hanley N, Lembo T, Sharp JP, Haydon DT, et al. Driving improvements in emerging disease surveillance through locally relevant capacity strengthening. Science. 2017;357(6347):146-8.
16. Ashley S, Holden S, Bazeley P. Livestock in poverty-focused development: Livestock in Development Crewekerne; 1999.

17. Catley A, Lind, J., Scoones, I. Development at the Margins: Pastoralism in the Horn of Africa. Pastoralism and Development in Africa: Dynamic Changes at the Margins2013. p. 1-26.
18. Ahuya C, Okeyo A, Peacock C. Developmental challenges and opportunities in the goat industry: The Kenyan experience. Small Ruminant Research. 2005;60(1):197-206.
19. Kebebe E, Duncan AJ, Klerkx L, De Boer I, Oosting S. Understanding socio-economic and policy constraints to dairy development in Ethiopia: A coupled functional-structural innovation systems analysis. Agricultural Systems. 2015;141:69-78.
20. Adams WMA. Wasting the Rain (Routledge Revivals): Rivers, People and Planning in Africa: Routledge; 2014.
21. Steinfeld H, Mack S. Livestock development strategies. World Animal Review. 1995;84(85):18-24.
22. Heffernan C. Livestock and the Poor: Issues in poverty-focused livestock development. BSAS OCCASIONAL PUBLICATION. 2004:229-46.
23. Sansoucy R. Livestock-a driving force for food security and sustainable development. World. 1995;3074(5389):1035.
24. Akabwai DM. Extension and livestock development: Experience from among the Turkana pastoralists of Kenya. 1992.
25. Roe EM. Development narratives, or making the best of blueprint development. World development. 1991;19(4):287-300.
26. Schelling E, Greter H, Kessely H, Abakar M, Ngandolo B, Crump L, et al. Human and animal health surveys among pastoralists. Revue scientifique et technique (International Office of Epizootics). 2016;35(2):659.
27. Thumbi S, Njenga MK, Marsh TL, Noh S, Otiang E, Munyua P, et al. Linking Human Health and Livestock Health: A "One-Health" Platform for Integrated Analysis of Human Health, Livestock Health, and Economic Welfare in Livestock Dependent Communities. PloS one. 2015;10(3):e0120761.
28. Kemunto N, Mogoa E, Osoro E, Bitek A, Njenga MK, Thumbi S. Zoonotic disease research in East Africa. BMC infectious diseases. 2018;18(1):545.
29. Perry B, Grace D. The impacts of livestock diseases and their control on growth and development processes that are pro-poor. Philosophical Transactions of the Royal Society B: Biological Sciences. 2009;364(1530):2643-55.
30. Gimbel S, Mwanza M, Nisingizwe MP, Michel C, Hirschhorn L. Improving data quality across 3 sub-Saharan African countries using the consolidated framework for implementation research (CFIR): results from the African health initiative. BMC health services research. 2017;17(3):828.
31. Mazalale J, Kambala C, Brenner S, Chinkhumba J, Lohmann J, Mathanga DP, et al. Factors associated with delivery outside a health facility: cross-sectional study in rural Malawi. Tropical Medicine & International Health. 2015;20(5):617-26.
32. Kimaro EG, Mor SM, Gwakisa P, Toribio J-A. Seasonal occurrence of Theileria parva infection and management practices amongst Maasai pastoralist communities in Monduli District, Northern Tanzania. Veterinary parasitology. 2017;246:43-52.
33. Wiederkehr C, Beckmann M, Hermans K. Environmental change, adaptation strategies and the relevance of migration in Sub-Saharan drylands. Environmental Research Letters. 2018;13(11):113003.

34. Melamed C. Development Data: How Accurate Are the Figures? The Guardian Blog. 2014.
35. Chowa G, Ansong D, Masa R. Assets and child well-being in developing countries: A research review. Children and Youth Services Review. 2010;32(11):1508-19.
36. Sankoh O. Global health estimates: stronger collaboration needed with low-and middle-income countries. PLoS Med. 2010;7(11):e1001005.
37. Byass P, De Courten M, Graham WJ, Laflamme L, McCaw-Binns A, Sankoh OA, et al. Reflections on the global burden of disease 2010 estimates. PLoS Med. 2013;10(7):e1001477.
38. Counotte MJ, Minbaeva G, Usubalieva J, Abdykerimov K, Torgerson PR. The Burden of Zoonoses in Kyrgyzstan: A Systematic Review. PLoS Negl Trop Dis. 2016;10(7):e0004831.
39. Franco JR, Simarro PP, Diarra A, Ruiz-Postigo JA, Jannin JG. The journey towards elimination of gambiense human African trypanosomiasis: not far, nor easy. Parasitology. 2014;141(6):748.
40. Adokiya MN, Awoonor-Williams JK, Beiersmann C, Müller O. The integrated disease surveillance and response system in northern Ghana: challenges to the core and support functions. BMC health services research. 2015;15(1):288.
41. de Clare Bronsvoort BM, Thumbi SM, Poole EJ, Kiara H, Auguet OT, Handel IG, et al. Design and descriptive epidemiology of the Infectious Diseases of East African Livestock (IDEAL) project, a longitudinal calf cohort study in western Kenya. BMC veterinary research. 2013;9(1):171-.
42. Tong M. Better data, better health care: Duke project aims to streamline health data in African border regions 2018 [Available from: https://www.dukechronicle.com/article/2018/11/better-data-better-health-care-duke-project-to-streamline-health-data-in-african-border-regions.
43. Uchendu FN. Hunger influenced life expectancy in war-torn Sub-Saharan African countries. Journal of Health, Population and Nutrition. 2018;37(1):11.
44. Chambers R. Rural development: Putting the last first. Longman Scientific Technology; 1983.
45. Bardosh KL, Scoones JC, Grace D, Kalema-Zikusoka G, Jones KE, de Balogh K, et al. Engaging research with policy and action: what are the challenges of responding to zoonotic disease in Africa? Phil Trans R Soc B. 2017;372(1725):20160172.
46. Lind J, Sabates-Wheeler R, Kohnstamm S, Caravani M, Eid A, Nightingale DM, et al. Changes in the drylands of eastern Africa: Case studies of pastoralist systems in the region. Nairobi: DFID East Africa Research Hub. 2016.
47. Christensen DL, Faurholt-Jepsen D, Birkegaard L, Mwaniki DL, Boit MK, Kilonzo B, et al. Cardiovascular risk factors in rural Kenyans are associated with differential age gradients, but not modified by sex or ethnicity. Annals of human biology. 2016;43(1):42-9.
48. Gning MC. Trade, political influence and liberalization: situating the poor in the political economy of livestock in Senegal. Pro-Poor Livestock Policy Initiative Working Paper. 2004;8.
49. Roberts R, Smith G, Bazer F, Cibelli J, Seidel G, Bauman D, et al. Farm animal research in crisis. Science. 2009;324(5926):468.

50. Richards J. Nuclear and Related Techniques for Solving Problems of Animal Production and Health: Development Context and Lessons Learned. Edited by NE Odongo, M Garcia & GJ Viljoen. 2010:3.
51. Perry B, Sones K. Science for development: poverty reduction through animal health. 2007.
52. Khapayi M, Celliers P. Factors limiting and preventing emerging farmers to progress to commercial agricultural farming in the King William's Town area of the Eastern Cape Province, South Africa. South African Journal of Agricultural Extension. 2016;44(1):25-41.
53. Sobják A. Corruption Risks in Infrastructure Investments in Sub-Saharan Africa. 2018.
54. Doumbia D. The quest for pro-poor and inclusive growth: the role of governance. Applied Economics. 2019;51(16):1762-83.
55. Millar J, Photakoun V. Livestock development and poverty alleviation: revolution or evolution for upland livelihoods in Lao PDR? International journal of agricultural sustainability. 2008;6(1):89-102.
56. Odongo N, Garcia M, Viljoen GJ. Sustainable improvement of animal production and health. Food and Agriculture Organization of the United Nations; 2010.
57. Craig P, Dieppe P, Macintyre S, Michie S, Nazareth I, Petticrew M. Developing and evaluating complex interventions: the new Medical Research Council guidance. Bmj. 2008;337.
58. Piper K. Scaling up good ideas is really, really hard — and we're starting to figure out why: Vox; 2018 [updated December 10th. Available from: https://www.vox.com/future-perfect/2018/12/10/18127987/global-health-poverty-development-scaling-economics-research-yrise-yale.
59. Jabbar MA, Ehui SK, Von Kaufmann R. Supply and demand for livestock credit in sub-Saharan Africa: Lessons for designing new credit schemes. World Development. 2002;30(6):1029-42.
60. Baum SE, Machalaba C, Daszak P, Salerno RH, Karesh WB. Evaluating one health: are we demonstrating effectiveness? One Health. 2017;3:5-10.
61. Johnsen K, Niamir-Fuller M, Bensada A, Waters-Bayer A. A Case of Benign Neglect: Knowledge Gaps about Sustainability in Pastoralism and Rangelands. 2019.
62. De Haan C, Robinson T, Conchedda G, Ericksen P, Said M, Robinson L, et al. Livestock production systems: seizing the opportunities for pastoralists and agro-pastoralists. 2016.
63. Raleigh C. Political marginalization, climate change, and conflict in African Sahel states. International studies review. 2010;12(1):69-86.
64. Union A. Policy framework for pastoralism in Africa: securing, protecting and improving the lives, livelihoods and rights of pastoralist communities. 2013.
65. Randall S. Where have all the nomads gone? Fifty years of statistical and demographic invisibilities of African mobile pastoralists. Pastoralism. 2015;5(1):1-22.
66. Little PD, McPeak J, Barrett CB, Kristjanson P. Challenging orthodoxies: understanding poverty in pastoral areas of East Africa. Development and Change. 2008;39(4):587-611.
67. Massawe GD, Urassa JK. Causes and management of land conflicts in Tanzania: A Case offarmers versus pastoralists. 2016.

68. López-i-Gelats F, Fraser ED, Morton JF, Rivera-Ferre MG. What drives the vulnerability of pastoralists to global environmental change? A qualitative meta-analysis. Global Environmental Change. 2016;39:258-74.
69. Koissaba BO. Effects of globalization in the Maasai Family ResearchGate2013 [Available from: https://www.researchgate.net/publication/249994886_Effects_of_globalization_in_the_Maasai_Family.
70. Archambault C. Re-creating the commons and re-configuring Maasai women's roles on the rangelands in the face of fragmentation. International Journal of the Commons. 2016;10(2).
71. Massoi L. Land conflicts and livelihoods of pastoral Maasai women in Kilosa District, Morogoro, Tanzania: Ghent University; 2015.
72. Davies J, Robinson LW, Ericksen PJ. Development process resilience and sustainable development: insights from the drylands of Eastern Africa. Society & Natural Resources. 2015;28(3):328-43.
73. Blench R. 'You Can't Go Home Again': Pastoralism in the New Millennium: Overseas Development Institute London; 2001.
74. Kristjanson P, Waters-Bayer A, Johnson N, Tipilda A, Njuki J, Baltenweck I, et al. Livestock and women's livelihoods. Gender in Agriculture: Springer; 2014. p. 209-33.
75. Peacock C. Goats--A pathway out of poverty. Small ruminant research : the journal of the International Goat Association. 2005;60(1-2):179-86.
76. Lebbie S. Goats under household conditions. Small ruminant research. 2004;51(2):131-6.
77. Dossa LH, Rischkowsky B, Birner R, Wollny C. Socio-economic determinants of keeping goats and sheep by rural people in southern Benin. Agriculture and human values. 2008;25(4):581-92.
78. Molyneux D, Hallaj Z, Keusch GT, McManus DP, Ngowi H, Cleaveland S, et al. Zoonoses and marginalised infectious diseases of poverty: Where do we stand? Parasites & vectors. 2011;4(1):348.
79. Grace D, Mutua F, Ochungo P, Kruska R, Jones K, Brierley L, et al. Mapping of poverty and likely zoonoses hotspots. 2012.
80. WHO. Research priorities for zoonoses and marginalized infections. World Health Organization technical report series. 2012(971):ix.
81. Zinsstag J, Schelling E, Roth F, Bonfoh B, De Savigny D, Tanner M. Human benefits of animal interventions for zoonosis control. Emerging infectious diseases. 2007;13(4):527.
82. Grace D. Zoonoses of poverty: Measuring and managing the multiple burdens of zoonoses and poverty. Zoonoses-Infections Affecting Humans and Animals: Springer; 2015. p. 1127-37.
83. Alonso S, Lindahl J, Roesel K, Traore SG, Yobouet BA, Ndour APN, et al. Where literature is scarce: observations and lessons learnt from four systematic reviews of zoonoses in African countries. Animal health research reviews. 2016;17(1):28-38.
84. Njeru J, Henning K, Pletz M, Heller R, Neubauer H. Q fever is an old and neglected zoonotic disease in Kenya: a systematic review. BMC public health. 2016;16(1):297.

85. Njeru J, Wareth G, Melzer F, Henning K, Pletz M, Heller R, et al. Systematic review of brucellosis in Kenya: disease frequency in humans and animals and risk factors for human infection. BMC public health. 2016;16(1):853.
86. Akinseye VO, Adesokan HK, Ogugua AJ, Adedoyin FJ, Otu PI, Kwaghe AV, et al. Sero-epidemiological survey and risk factors associated with bovine brucellosis among slaughtered cattle in Nigeria. Onderstepoort Journal of Veterinary Research. 2016;83(1):1-7.
87. Ducrotoy MJ. Livelihoods of Fulani pastoralists and burden of bacterial zoonoses in the Kachia grazing reserve, Nigeria: University of Edinburgh; 2015.
88. Nakeel M, Arimi S, Kitala P, Nduhiu G, Njenga J, Wabacha J. A Sero-epidemiological Survey of Brucellosis, Q-Fever and Leptospirosis in Livestock and Humans and Associated Risk Factors in Kajiado County-Kenya. Journal of Tropical Diseases & Public Health. 2016.
89. de Glanville WA, Conde-Álvarez R, Moriyón I, Njeru J, Díaz R, Cook EA, et al. Poor performance of the rapid test for human brucellosis in health facilities in Kenya. PLoS neglected tropical diseases. 2017;11(4):e0005508.
90. Assenga JA, Matemba LE, Muller SK, Malakalinga JJ, Kazwala RR. Epidemiology of Brucella infection in the human, livestock and wildlife interface in the Katavi-Rukwa ecosystem, Tanzania. BMC veterinary research. 2015;11(1):189.
91. Germeraad EA, Hogerwerf L, Faye-Joof T, Goossens B, van der Hoek W, Jeng M, et al. Low seroprevalence of brucellosis in humans and small ruminants in the Gambia. PloS one. 2016;11(11):e0166035.
92. Fratkin E. East African pastoralism in transition: Maasai, Boran, and Rendille cases. African Studies Review. 2001;44(03):1-25.
93. Herskovits MJ. The Cattle Complex in East Africa. American Anthropologist. 1926;28(2):361-88.
94. Bollig M. Risk management in a hazardous environment: A comparative study of two pastoral societies: Springer Science & Business Media; 2010.
95. OXFAM. Pastoralism demographics, settlement and service provision in the Horn and East Africa: Transformation and Opportunities. 2010.
96. IFAD. Livestock and Pastoralists 2009 [cited 2015 July 10th, 2015]. Available from: http://www.ifad.org/lrkm/factsheet/pastoralists.pdf.
97. Boto I, Ededme J, Lopez I. Resources on new challenges and opportunities for pastoralism in the context of African countries 2012 [cited 2015 July 10]. Available from: https://brusselsbriefings.files.wordpress.com/2012/10/reader-br-26-pastoralism.pdf.
98. Linseele V. Did Specialized Pastoralism Develop Differently in Africa than in the Near East? An Example from the West African Sahel. Journal of World Prehistory. 2010;23(2):43-77.
99. McGahey D, Davies J, Hagelberg N, Ouedraogo R. Pastoralism and the Green Economy - a Natural Nexus? Status, Challenges and Policy Implications: IUCN and UNEP; 2014. 58 p.
100. Zinsstag J, Ould Taleb M, Craig P. Editorial: health of nomadic pastoralists: new approaches towards equity effectiveness. Tropical Medicine & International Health. 2006;11(5):565-8.

101. Randall S. Data on pastoralist populations. Oxfam Policy and Practice: Agriculture, Food and Land. 2005;5(2):1-15.
102. Devereux S. Better marginalised than incorporated? Pastoralist livelihoods in Somali Region, Ethiopia. The European Journal of Development Research. 2010;22(5):678-95.
103. Fratkin E. Ethiopia's Pastoralist Policies: Development. Displacment and Resettlement. Nomadic Peoples. 2014;18(1):94-114.
104. Mlekwa VM. State, pastoralists and education in Tanzania: how can conflicts and tensions be resolved? Utafiti Journal. 1996;3(1).
105. Saverio K. Animal Science and the Representation of Local Breeds. Healing the herds: disease, livestock economies, and the globalization of veterinary medicine: Ohio University Press; 2010.
106. German L, King E, Unks R, Wachira NP. This side of subdivision: Individualization and collectivization dynamics in a pastoralist group ranch held under collective title. Journal of Arid Environments. 2017;144:139-55.
107. Mcpeak J, Little PD. Cursed if you do, cursed if you don't. As pastoralists settle: Springer; 2006. p. 87-104.
108. Homewood K, Trench PC, Kristjanson P. Staying Maasai? Pastoral livelihoods, diversification and the role of wildlife in development. Staying Maasai?: Springer; 2009. p. 369-408.
109. Cullis A. Pastoralism in Crisis. Future Agricultures. 2011.
110. Hampshire K. Networks of nomads: negotiating access to health resources among pastoralist women in Chad. Social science & medicine. 2002;54(7):1025-37.
111. Fratkin E. Seeking alternative livelihoods in pastoral areas. Pastoralism and Development in Africa: Dynamic Change at the Margins New York: Routledge2013. p. 197-205.
112. Little PD, Smith K, Cellarius BA, Coppock DL, Barrett C. Avoiding disaster: diversification and risk management among East African herders. Development and Change. 2001;32(3):401-33.
113. Galaty JG. 'Unused' land and unfulfilled promises: justifications for displacing communities in East Africa. Nomadic Peoples. 2014;18(1):80.
114. Gerber P. Livestock in a changing landscape, volume 2: Experiences and regional perspectives: Island Press; 2010.
115. Galvin KA. Transitions: pastoralists living with change. Annual Review of Anthropology. 2009;38:185-98.
116. Galvin KA, Reid RS, Behnke R, Hobbs NT. Fragmentation in semi-arid and arid landscapes. Consequences for Human and Natural Systems Dordrecht, The Neth: Springer. 2008.
117. Mwangi E. The puzzle of group ranch subdivision in Kenya's Maasailand. Development and Change. 2007;38(5):889-910.
118. Galaty JG. " The Land Is Yours": Social and Economic Factors in the Privatization, Sub-Division and Sale of Maasai Ranches. Nomadic peoples. 1992:26-40.
119. Galaty JG. Land grabbing in the Eastern African rangelands. Pastoralism and development in Africa: Dynamic change at the margins. 2013:143-53.
120. Galaty JG. The Collapsing Platform for Pastoralism: Land Sales and Land Loss in Kajiado County, Kenya. Nomadic Peoples. 2013;17(2):20-39.

121. Goodman R. Pastoral livelihoods in Tanzania: can the Maasai benefit from conservation? Current Issues in Tourism. 2002;5(3-4):280-6.
122. Meinzen-Dick R, Mwangi E. Cutting the web of interests: Pitfalls of formalizing property rights. Land Use Policy. 2009;26(1):36-43.
123. Hodgson DL. "My Daughter… Belongs to the Government Now": Marriage, Maasai and the Tanzanian State. Canadian Journal of African Studies/La Revue canadienne des études africaines. 1996;30(1):106-23.
124. McCabe JT, Leslie PW, DeLuca L. Adopting cultivation to remain pastoralists: the diversification of Maasai livelihoods in northern Tanzania. Human Ecology. 2010;38(3):321-34.
125. Bollig M, Schnegg M, Wotzka H-P. Pastoralism in Africa: Past, present and future: Berghahn Books; 2013.
126. Nyanjom O. Remarginalising Kenyan pastoralists: the hidden curse of national growth and development. 2014.
127. Galaty JG, editor States of Violence: Ethnicity, Politics, and Pastoral Conflict in East Africa. Geography Research Forum; 2016.
128. Koissaba BO. Elusive Justice: The Maasai Contestation of Land Appropriation in Kenya: A Historical and Contemporary Perspective. Kenya After 50: Springer; 2016. p. 189-219.
129. Mwangi E. Socioeconomic change and land use in Africa: the transformation of property rights in Maasailand: Springer; 2016.
130. Homewood K, Coast E, Kiruswa S, Serneels S, Thompson M, Trench P. Maasai pastoralists: diversification and poverty. 2006.
131. Elias E, Abdi F. Putting pastoralists on the policy agenda: Land alienation in Southern Ethiopia: IIED London; 2010.
132. Martin R, Linstädter A, Frank K, Müller B. Livelihood security in face of drought–assessing the vulnerability of pastoral households. Environmental Modelling & Software. 2016;75:414-23.
133. Smith NM. Gender and livelihood diversification: Maasai women's market activities in Northern Tanzania. The Journal of Development Studies. 2015;51(3):305-18.
134. Western D, Manzolillo Nightingale D. Environmental change and the vulnerability of pastoralists to drought: a case study of the Maasai in Amboseli, Kenya. 2003.
135. Quandt A, Kimathi YA. Perceptions of the effects of floods and droughts on livelihoods: lessons from arid Kenya. International Journal of Climate Change Strategies and Management. 2017;9(03):337-51.
136. Behnke R, Muthami D. The contribution of livestock to the Kenyan economy. IGAD Livestock Policy Initiative Working Paper. 2011(03-11).
137. Talle A. Pastoralists at the border: Maasai poverty and the development discourse in Tanzania. The Poor are not us. 1999:106-24.
138. Broch-Due V. Remembered cattle, forgotten people: the morality of exchange and the exclusion of the Turkana poor. The Poor are not Us: Poverty and Pastoralism1999.
139. Hodgson DL. "These Are Not Our Priorities": Maasai Women, Human Rights, and the Problem ofCulture. Gender and Culture at the Limit of Rights. 2011:138.
140. Muchomba FM. Colonial policies and the rise of transactional sex in Kenya. Journal of International Women's Studies. 2014;15(2):80.

141. White L. The comforts of home: Prostitution in colonial Nairobi: University of Chicago Press; 2009.
142. Vocativ. The Beach Boys: Objects of Desire. 2013.
143. McCabe J, Smith N, Leslie P, Telligman A. Livelihood Diversification through Migration among a Pastoral People: Contrasting Case Studies of Maasai in Northern Tanzania. Human Organization. 2014;73(4):389-400.
144. Fratkin E, Roth EA. As pastoralists settle: The social, health, and economic consequences of the pastoral sedentarization in Marsabit District, Northern Kenya. As Pastoralists Settle. 1: Springer Science & Business Media; 2006. p. 1-28.
145. Bollig M, Schnegg M. Introduction. In: Bollig M, Schnegg M, Wotzka H-P, editors. Pastoralism in Africa: past, present and future
United States: Berghahn Books; 2013.
146. McCabe JT. Sustainability and livelihood diversification among the Maasai of northern Tanzania. Human Organization. 2003;62(2):100-11.
147. Kristjanson P, Mango N, Krishna A, Radeny M, Johnson N. Understanding poverty dynamics in Kenya. Journal of international development. 2010;22(7):978-96.
148. Little PD. Income diversification among pastoralists: Lessons for policy makers. Policy Brief. 2009;3.
149. Fratkin E, Nathan MA, Roth EA. Health consequences of pastoral sedentarization among Rendille of Northern Kenya. The Poor are Not Us: Poverty and Pastoralism. 1999:149-63.
150. Greter H, Batil AA, Ngandolo BN, Alfaroukh IO, Moto DD, Hattendorf J, et al. Human and livestock trematode infections in a mobile pastoralist setting at Lake Chad: added value of a One Health approach beyond zoonotic diseases research. Transactions of The Royal Society of Tropical Medicine and Hygiene. 2017;111(6):278-84.
151. Lawson DW, Mulder MB, Ghiselli ME, Ngadaya E, Ngowi B, Mfinanga SG, et al. Ethnicity and child health in northern Tanzania: Maasai pastoralists are disadvantaged compared to neighbouring ethnic groups. PLoS One. 2014;9(10):e110447.
152. Schelling E, Daoud S, Daugla D, Diallo P, Tanner M, Zinsstag J. Morbidity and nutrition patterns of three nomadic pastoralist communities of Chad. Acta tropica. 2005;95(1):16-25.
153. Chabasse D, Roure C, Ranque P, Quilici M. The health of nomads and semi-nomads of the Malian Gourma: an epidemiological approach. 1985.
154. Wang H, Naghavi M, Allen C, Vollset SE, Knudsen AK, Hailu A, et al. Global, regional, and national life expectancy, all-cause mortality, and cause-specific mortality for 249 causes of death, 1980-2015: a systematic analysis for the Global Burden of Disease Study 2015. 2016.
155. Catley A. Pastoralism in Crisis? A response. Future Agricultures. 2011.
156. Gaym A. Maternal mortality studies in Ethiopia--magnitude, causes and trends. Ethiopian medical journal. 2009;47(2):95-108.
157. Hill AG, editor The recent demographic surveys in Mali and their main findings. Population, health and nutrition in the Sahel: issues in the welfare of selected west African communities; 1985: KPI.

158. Montavon A, Jean-Richard V, Bechir M, Daugla D, Abdoulaye M, Naré B, et al. Health of mobile pastoralists in the Sahel–assessment of 15 years of research and development. Tropical Medicine & International Health. 2013;18(9):1044-52.
159. Schelling E, Diguimbaye C, Daoud S, Nicolet J, Zinsstag J. Seroprevalences of zoonotic diseases in nomads and their livestock in Chari-Baguirmi, Chad. France2004. p. 474.
160. Gumi B, Schelling E, Berg S, Firdessa R, Erenso G, Mekonnen W, et al. Zoonotic transmission of tuberculosis between pastoralists and their livestock in South-East Ethiopia. EcoHealth. 2012;9(2):139-49.
161. Asakura S, Makingi G, Kazwala R, Makita K. Herd-level risk factors associated with Brucella sero-positivity in cattle, and perception and behaviours on the disease control among agro-pastoralists in Tanzania. Acta tropica. 2018;187:99-107.
162. Shirima G, FitzPatrick J, Kunda J, Mfinanga G, Kazwala R, Kambarage D, et al. The role of livestock keeping in human brucellosis trends in livestock keeping communities in Tanzania. Tanzania Journal of Health Research. 2010;12(3):203-7.
163. Coast E. Wasting semen: context and condom use among the Maasai. Culture, health & sexuality. 2007;9(4):387-401.
164. Sheik-Mohamed A, Velema J. Where health care has no access: the nomadic populations of sub-Saharan Africa. Tropical medicine & international health. 1999;4(10):695-707.
165. Bechir M, Schelling E, Moto D, Tanner M, Zinsstag J. Nutritional status and dietary diversity in nomadic and sedentary rural women on the southeast bank of Lake Chad. Medecine tropicale: revue du Corps de sante colonial. 2011;71(6):582-7.
166. Bechir M, Schelling E, Bonfoh B, Seydi M, Wade S, Moto DD, et al. Seasonal variations in the nutritional status of nomad and sedentary children less than 5 years of age living in the Sahel in Chad. France2010. p. 353.
167. Cummings MJ, Wamala JF, Komakech I, Malimbo M, Lukwago L. Emerging and reemerging epidemic-prone diseases among settling nomadic pastoralists in Uganda. Acta tropica. 2014;137:19-24.
168. Chabasse D, Roure C, Rhaly A, Maiga D, Traore M. Evaluation de l'etat sanitaire des populations nomades et semi-nomades du Gourma-Mali-approche epidemiologique II.-Resultats globaux et conclusion. Med Trop. 1983;43:127-35.
169. Magoma M, Requejo J, Campbell OMR, Cousens S, Filippi V. High ANC coverage and low skilled attendance in a rural Tanzanian district: a case for implementing a birth plan intervention. BMC pregnancy and childbirth. 2010;10(1):13-.
170. Zingore S, Gonzalez-Estrada E, Delve RJ, Herrero M, Dimes JP, Giller KE. An integrated evaluation of strategies for enhancing productivity and profitability of resource-constrained smallholder farms in Zimbabwe. Agricultural systems. 2009;101(1-2):57-68.
171. Gele AA, Bjune G, Abebe F. Pastoralism and delay in diagnosis of TB in Ethiopia. BMC public health. 2009;9(1):5-.
172. Cummings MJ, Wamala JF, Komakech I, Lukwago L, Malimbo M, Omeke ME, et al. Hepatitis E in Karamoja, Uganda, 2009–2012: epidemiology and challenges to control in a setting of semi-nomadic pastoralism. Transactions of the Royal Society of Tropical Medicine and Hygiene. 2014;108(10):648-55.

173. Diener E, Suh E, Oishi S. Recent findings on subjective well-being. Indian journal of clinical psychology. 1997;24:25-41.
174. Dodge R, Daly A, Huyton J, Sanders L. The challenge of defining wellbeing. International Journal of Wellbeing. 2012;2(3):222-35.
175. Diener E, Lucas RE, Scollon CN. Beyond the hedonic treadmill: revising the adaptation theory of well-being. American Psychologist. 2006;61(4):305.
176. Sheldon KM, Boehm JK, Lyubomirsky S. Variety is the spice of happiness: The hedonic adaptation prevention (HAP) model. Oxford handbook of happiness. 2012:901-14.
177. Lucas RE. Adaptation and the set-point model of subjective well-being does happiness change after major life events? Current Directions in Psychological Science. 2007;16(2):75-9.
178. Biswas-Diener R, Diener E. Making the best of a bad situation: Satisfaction in the slums of Calcutta. Social Indicators Research. 2001;55(3):329-52.
179. Alkire S, Foster J, Seth S, Santos ME, Roche JM, Ballon P. Multidimensional poverty measurement and analysis: Oxford University Press, USA; 2015.
180. Alkire S, Seth S. Determining BPL status: some methodological improvements. The Indian Journal of Human Development. 2009;2(2):407-24.
181. UNDP. Multidimensional Poverty Index (MPI) [cited 2015 July 8th]. Available from: http://hdr.undp.org/en/content/multidimensional-poverty-index-mpi.
182. Gough I, McGregor JA, MyiLibrary. Wellbeing in developing countries: from theory to research. Cambridge; New York: Cambridge University Press; 2007.
183. Kahneman D, Krueger AB, Schkade D, Schwarz N, Stone AA. Would you be happier if you were richer? A focusing illusion. science. 2006;312(5782):1908-10.
184. Diener E, Biswas-Diener R. Will money increase subjective well-being? Social indicators research. 2002;57(2):119-69.
185. Biswas-Diener R, Vittersø J, Diener E. Most people are pretty happy, but there is cultural variation: The Inughuit, the Amish, and the Maasai. Journal of Happiness Studies. 2005;6(3):205-26.
186. Woodhouse E, McCabe JT. Well-being and conservation: diversity and change in visions of a good life among the Maasai of northern Tanzania. Ecology and Society. 2018;23(1).
187. Melamed C. Post-2015: The road ahead. Overseas Development. 2012.
188. Bank W. Atlas of Sustainable Development Goals 2017: Washington, DC: World Bank; 2017.
189. UN. The millennium development goals report 2015: United Nations Publications; 2015.
190. Radeny M, Van den Berg M, Schipper R. Rural Poverty Dynamics in Kenya: Structural Declines and Stochastic Escapes. World Development. 2012;40(8):1577-93.
191. Chen S, Ravallion M. The developing world is poorer than we thought, but no less successful in the fight against poverty. World Bank Policy Research Working Paper Series, Vol. 2008.
192. Group WB, World Bank e-L. Poverty and Shared Prosperity 2016: Taking on Inequality. US: World Bank Publications; 2016.
193. WB. World Bank Data: Country Kenya [cited 2015 July 20th]. Available from: http://data.worldbank.org/country/kenya.

194. Alkire SaR, Gisela. Global Multidimensional Poverty Index 20172017.
195. Kenya GDP 2019 [Available from: http://www.tradingeconomics.com/kenya/gdp-growth-annual.
196. Kenya Country Briefing, Multidimensional Poverty Index Data Bank: OPHI, University of Oxford; 2017 [cited 2017 June 3rd]. Available from: http://www.ophi.org.uk/multidimensional-poverty-index/mpi-2015/mpi-country-briefings/.
197. Sumner A. Global Poverty and the "New Bottom Billion" Revisited: Exploring The Paradox That Most Of The World's Extreme Poor No Longer Live In The World's Poorest Countries. IDS Working Paper: University of Sussex; 2012.
198. Turner S, Cilliers J, Hughes B. Reducing poverty in Africa: realistic targets for the post-2015 MDGs and Agenda 2063. 2014.
199. Asiimwe D. East Africa: Rwanda Has Region's Highest Inequality Rate. The East African. 2017.
200. Odusola AF, Cornia GA, Bhorat H, Conceição P. Income inequality trends in sub-Saharan Africa: divergence, determinants and consequences: United Nations Development Programme, Regional Bureau for Africa; 2017.
201. ISS. Failure to reduce poverty threatens Kenya's economic success 2015 [updated February 18th, 2015. Available from: https://www.issafrica.org/about-us/press-releases/failure-to-reduce-poverty-threatens-kenyas-economic-success.
202. Bardhan P. Corruption and development: a review of issues. Journal of economic literature. 1997;35(3):1320-46.
203. Hope Sr KR. Kenya's corruption problem: causes and consequences. Commonwealth & Comparative Politics. 2014;52(4):493-512.
204. Persson A, Rothstein B, Teorell J. Why anticorruption reforms fail—systemic corruption as a collective action problem. Governance. 2013;26(3):449-71.
205. Klopp JM. Pilfering the public: the problem of land grabbing in contemporary Kenya. Africa Today. 2000;47(1):7-26.
206. Misaro J. Socio-economic Status And Participatory Development In Kenya. 2013.
207. UNDP. Millennium Development Goals: Status Report for Kenya 2013. 2013.
208. Pape UaM-M, C. More than just growth: Accelerating poverty reduction in Kenya: World Bank; 2019 [Available from: https://blogs.worldbank.org/africacan/more-than-just-growth-accelerating-poverty-reduction-in-kenya.
209. KNBS. Volume 1C-Population Distribution by Age, Sex and Administrative Units.pdf>. 2010.
210. KNBS. Basic Report on Well-being in Kenya. 2007 April.
211. Narayan D, Nyamwaya D. Learning from the poor: A participatory poverty assessment in Kenya1996.
212. Switzer HD. When the light is fire: Maasai schoolgirls in contemporary Kenya: University of Illinois Press; 2018.
213. Boone RB, BurnSilver SB, Thornton PK, Worden JS, Galvin KA. Quantifying Declines in Livestock Due to Land Subdivision. Rangeland Ecology & Management. 2005;58(5):523-32.
214. McPeak J. Confronting the risk of asset loss: Livestock exchange in northern Kenya. Unpublished MS, Department of Agricultural Resource and Managerial Economics, Cornell University. 2001.

215. Miller EM. Maternal hemoglobin depletion in a settled northern Kenyan pastoral population. American Journal of Human Biology. 2010;22(6):768-74.
216. Bryan E, Ringler C, Okoba B, Roncoli C, Silvestri S, Herrero M. Adapting agriculture to climate change in Kenya: Household strategies and determinants. Journal of environmental management. 2013;114:26-35.
217. McCabe JT. Success and failure: the breakdown of traditional drought coping institutions among the pastoral Turkana of Kenya. Journal of Asian and African studies. 1990;25(3-4):146-60.
218. Hassen A. Vulnerability to drought risk and famine: Local responses and external interventions among the Afar of Ethiopia, a study on the Aghini Pastoral Community 2008.
219. Lybbert TJ, Barrett CB, Desta S, Layne Coppock D. Stochastic wealth dynamics and risk management among a poor population. The Economic Journal. 2004;114(498):750-77.
220. McPeak JG, Barrett CB. Differential risk exposure and stochastic poverty traps among East African pastoralists. American Journal of Agricultural Economics. 2001;83(3):674-9.
221. McSherry B, Brass JN. The political economy of pro-poor livestock policy reform in Kenya. Intergovernmental Authority on Development, Nairobi. 2008.
222. Haro GO, Doyo GJ, McPeak JG. Linkages between community, environmental, and conflict management: Experiences from Northern Kenya. World development. 2005;33(2):285-99.
223. Mkutu KA. Small arms and light weapons among pastoral groups in the Kenya–Uganda border area. African Affairs. 2007;106(422):47-70.
224. Witsenburg KM, Adano WR. Of rain and raids: Violent livestock raiding in northern Kenya. Civil Wars. 2009;11(4):514-38.
225. Jahnke HE, Jahnke HE. Livestock production systems and livestock development in tropical Africa: Kieler Wissenschaftsverlag Vauk Kiel; 1982.
226. Hodgson DL. "Once Intrepid Warriors": Modernity and the Production of Maasai Masculinities. Ethnology. 1999;38(2):121-50.
227. Behnke R, Metaferia F. the contribution of livestock to the Ethiopian economy–part II. IGAD LPI Working Paper; 2011.
228. Behnke R, Nakirya M. The contribution of livestock to the Ugandan economy. IGAD Livestock Policy Initiative Working Paper. 2012(02-12).
229. Grandin BE. Wealth and pastoral dairy production: A case study from Maasailand. Human Ecology. 1988;16(1):1-21.
230. DVO N. 2008.
231. SID Ka. Exploring Inequality: Pulling Apart or Pooling Together: Narok County. 2013.
232. SID Ka. Exploring Kenya's Inequalities: Pulling Together or Pooling Apart (Abridged Report). 2013:44.
233. GOK. Narok District Environmental Action Plan 2009-2013. 2009.
234. Koissaba B. Entrenched corruption and impunity continues in Kenya 2015 [Available from: https://www.culturalsurvival.org/news/entrenched-corruption-and-impunity-continues-kenya.
235. Kenya National Assembly Official Record (Hansard), National Assembly (May 26, 2004).

236. Sapit D. Narok Strategic Plan (Draft). 2011.
237. Kurgat M. Why Narok Governor Tunai Is Under Siege. The Star Niasa Magazine. 2014:5.
238. Otuki. Narok Gets Funds for Poor Despite Topping Rich Counties List. Business Daily. 2014.
239. Dowling JM, Yap C-F. Happiness and poverty in developing countries: a global perspective. New York; Houndmills, Basingstoke, Hampshire: Palgrave Macmillan; 2013.
240. Gupta S, Davoodi H, Alonso-Terme R. Does corruption affect income inequality and poverty? Economics of governance. 2002;3(1):23-45.
241. Matter SE. Struggles over belonging: Insecurity, inequality and the cultural politics of property at Enoosupukia, Kenya [Ph.D.]. Ann Arbor: McGill University (Canada); 2011.
242. Behnke Jr RH. The drivers of fragmentation in arid and semi-arid landscapes. Fragmentation in Semi-Arid and Arid Landscapes: Springer; 2008. p. 305-40.
243. Otte J, Costales A, Dijkman J, Pica-Ciamarra U, Robinson T, Ahuja V, et al. Livestock sector development for poverty reduction: an economic and policy perspective. Livestock's many virtues: Food and Agriculture Organization of the United Nations (FAO); 2012.
244. McLeod A. World livestock 2011-livestock in food security: Food and Agriculture Organization of the United Nations (FAO); 2011.
245. Heffernan C, Misturelli F. The delivery of veterinary services to the poor: Preliminary findings from Kenya. Report of the DFID Project. 2000;7359.
246. Ahuja V, Redmond E. Livestock services and the poor. Tropical Animal Health and Production. 2004;36(3):247-68.
247. ILRI. One Health, Ecohealth and Agriculture Associated Diseases- Report of a Regional Dialogue. Nairobi: ILRI; 2013 November 25th, 2013.
248. Blench R, Chapman R, Slaymaker T. A Study of the Role of Livestock in Poverty Reduction Strategy Papers (PRSPs). 2003.
249. Mugisha A, McLeod A, Percy R, Kyewalabye E. Socio-economic factors influencing control of vector-borne diseases in the pastoralist system of south western Uganda. Tropical animal health and production. 2008;40(4):287-97.
250. Vanleeuwen J. 2018.
251. Leary N, Conde C, Kulkarni J, Nyong A, Adejuwon J, Barros V, et al. Climate Change and Vulnerability and Adaptation: Two Volume Set: Routledge; 2008.
252. Homann S. Indigenous knowledge of Borana pastoralists in natural resource management: a case study from southern Ethiopia: Cuvillier Verlag; 2005.
253. Kristjanson P, Krishna A, Radeny M, Nindo W. Pathways out of Poverty in Western Kenya and the Role of Livestock. FAO. 2004.
254. KARI. Policy Responses to Food Crisis in Kenya 2012 [cited 2015 August 11th]. Available from: http://www.foodsecurityportal.org/kenya/food-security-report-prepared-kenya-agricultural-research-institute.
255. Alila PO, Atieno R, editors. Agricultural policy in Kenya: issues and processes. Future Agricultures, A paper for the Future Agricultures Consortium workshop, Institute of Development Studies; 2006.
256. ICPALD. The Contribution of Livestock to the Kenyan Economy 2013 [updated August 2013; cited 2105 August 9th]. Available from:

http://igad.int/attachments/714_The%20Contribution%20of%20Livestock%20to%20the%20Kenyan%20Economy.pdf.
257. Davies J. Total economic valuation of Kenyan pastoralism. World Initiative for Sustainable Pastoralism International Union for Conservation of Nature (IUCN), Nairobi. 2007.
258. Evangelou P. Livestock development in Kenya's Maasailand: pastoralists' transition to a market economy: Westview Press; 1984.
259. Githinji JW. Strategic management practices adopted by the directorate of veterinary services, ministry of agriculture, livestock and fisheries, Kenya: University of Nairobi; 2014.
260. Aklilu Y. Livestock marketing in Kenya and Ethiopia: a review of policies and practice. Feinstein International Center, Addis Ababa. 2008;38.
261. Catley A, Mohammed A. The use of livestock-disease scoring by a primary animal-health project in Somaliland. Preventive Veterinary Medicine. 1996;28(3):175-86.
262. Tarawali S, de Haan C. Livestock in a Changing Landscape: Experiences and Regional Perspectives. 2010.
263. Zander KK, Mwacharo JM, Drucker AG, Garnett ST. Constraints to effective adoption of innovative livestock production technologies in the Rift Valley (Kenya). Journal of arid environments. 2013;96:9-18.
264. Bardosh K. One Health: science, politics and zoonotic disease in Africa: Routledge; 2016.
265. OIE-WHO. Who-OIE Operational Framework for Good Governance at the Human-animal Interface. 2014.
266. Ngumbi AF, Silayo RS. A cross-sectional study on the use and misuse of trypanocides in selected pastoral and agropastoral areas of eastern and northeastern Tanzania. Parasites & vectors. 2017;10(1):607.
267. Assefa S, Shibeshi W. Drug resistance in African animal trypanosomes: A review. African Journal of Microbiology Research. 2018;12(17):380-6.
268. Dar OA, Hasan R, Schlundt J, Harbarth S, Caleo G, Dar FK, et al. Exploring the evidence base for national and regional policy interventions to combat resistance. The Lancet. 2016;387(10015):285-95.
269. Brückner G. The role of the World Organisation for Animal Health (OIE) to facilitate the international trade in animals and animal products. Onderstepoort J Vet. 2009;76:141-6.
270. Akindola RB. Towards a definition of poverty: poor people's perspectives and implications for poverty reduction. Journal of Developing Societies. 2009;25(2):121-50.
271. Thornton P. Mapping poverty and livestock in the developing world: ILRI (aka ILCA and ILRAD); 2002.
272. Roth F, Zinsstag J, Orkhon D, Chimed-Ochir G, Hutton G, Cosivi O, et al. Human health benefits from livestock vaccination for brucellosis: case study. Bulletin of the World health Organization. 2003;81(12):867-76.
273. Zinsstag J, Roth F, Orkhon D, Chimed-Ochir G, Nansalmaa M, Kolar J, et al. A model of animal–human brucellosis transmission in Mongolia. Preventive veterinary medicine. 2005;69(1):77-95.
274. Knobel DL, Cleaveland S, Coleman PG, Fèvre EM, Meltzer MI, Miranda MEG, et al. Re-evaluating the burden of rabies in Africa and Asia. Bulletin of the World health Organization. 2005;83(5):360-8.

275. Rich KM, Perry BD. The economic and poverty impacts of animal diseases in developing countries: new roles, new demands for economics and epidemiology. Preventive veterinary medicine. 2011;101(3):133-47.
276. Birch I, Shuria HA. Perspectives on pastoral development: a casebook from Kenya: Oxfam; 2001.
277. Wanyoike F, Baker D. Pro-poor livestock development: Analysis of performance of projects and lessons. 2011.
278. Curran MM, MacLehose H. Community animal health services for improving household wealth and health status of low-income farmers. Tropical Animal Health and Production. 2002;34(6):449-70.
279. Berti PR, Krasevec J, FitzGerald S. A review of the effectiveness of agriculture interventions in improving nutrition outcomes. Public health nutrition. 2004;7(05):599-609.
280. Leroy JL, Frongillo EA. Can interventions to promote animal production ameliorate undernutrition? Journal of Nutrition. 2007;137:2311-6.
281. Kosgey I, Baker R, Udo H, Van Arendonk J. Successes and failures of small ruminant breeding programmes in the tropics: a review. Small Ruminant Research. 2006;61(1):13-28.
282. Doucouliagos H, Paldam M. The aid effectiveness literature: The sad results of 40 years of research. Journal of Economic Surveys. 2009;23(3):433-61.
283. Kingsbury D, McKay J, Hunt J, McGillivray M, Clarke M. International development: Issues and challenges: Palgrave Macmillan; 2012.
284. Khalaf M. Women's Control Over Economic Resources and Access to Financial Resources: United Nations Publications; 2009.
285. FAO I. World Bank (2008) Gender in Agriculture Sourcebook. World Bank, Washington DC.
286. Evans J, Klasing A. Discrimination, Inequality, and Poverty—A Human Rights Perspective. December; 2012.
287. Devereux S. Livelihood insecurity and social protection: a re-emerging issue in rural development. Development policy review. 2001;19(4):507-19.
288. Roser M. Agricultural Employment. Online Available at: https://ourworldindata org/data/food-agriculture/agricultural-employment. 2016.
289. Prakash A, Stigler M. FAO statistical yearbook. Food and Agriculture Organization of the United Nations, Rome. 2012.
290. Hawkes C, Ruel M. The links between agriculture and health: an intersectoral opportunity to improve the health and livelihoods of the poor. Bulletin of the World Health Organization. 2006;84(12):984-90.
291. WB. World development report 2008: agriculture for development. Washington, D.C; London: World Bank; 2007.
292. EC. Fruit and vegetables: Producer organisations. 2015.
293. Omballa VO, Musyoka RN, Vittor AY, Wamburu KB, Wachira CM, Waiboci LW, et al. Serologic evidence of the geographic distribution of bacterial zoonotic agents in Kenya, 2007. The American journal of tropical medicine and hygiene. 2016;94(1):43-51.
294. Muricho DN, Otieno DJ, Oluoch-Kosura W, Jirström M. Building pastoralists' resilience to shocks for sustainable disaster risk mitigation: Lessons from West Pokot County, Kenya. International Journal of Disaster Risk Reduction. 2018.

295. De Haan C, Ericksen P, Said M, Robinson L, Flintan F, Shaw A, et al. Trends and drivers of vulnerability in SSA drylands. 2016.
296. Ambelu A, Birhanu Z, Tesfaye A, Berhanu N, Muhumuza C, Kassahun W, et al. Intervention pathways towards improving the resilience of pastoralists: A study from Borana communities, southern Ethiopia. Weather and Climate Extremes. 2017;17:7-16.
297. Ameso E, Bukachi S, Olungah C, Haller T, Wandibba S, Nangendo S. Pastoral Resilience among the Maasai Pastoralists of Laikipia County, Kenya. Land. 2018;7(2):78.
298. Moritz M, Ewing D, Garabed R. On not knowing zoonotic diseases: Pastoralists' ethnoveterinary knowledge in the far north region of Cameroon. Human organization. 2013;72(1):1-11.
299. Mangesho PE, Neselle MO, Karimuribo ED, Mlangwa JE, Queenan K, Mboera LE, et al. Exploring local knowledge and perceptions on zoonoses among pastoralists in northern and eastern Tanzania. PLoS neglected tropical diseases. 2017;11(2):e0005345.
300. Bedelian C, Nkedianye D, Herrero M. Maasai perception of the impact and incidence of malignant catarrhal fever (MCF) in southern Kenya. Preventive veterinary medicine. 2007;78(3):296-316.
301. Wesonga F, Kitala P, Gathuma J, Njenga M, Ngumi P. An assessment of tick-borne diseases constraints to livestock production in a smallholder livestock production system in Machakos District, Kenya. 2010.
302. Bett B, Jost C, Allport R, Mariner J. Using participatory epidemiological techniques to estimate the relative incidence and impact on livelihoods of livestock diseases amongst nomadic pastoralists in Turkana South District, Kenya. Preventive Veterinary Medicine. 2009;90(3):194-203.
303. Ocaido M, Otim C, Okuna N, Erume J, Ssekitto C, Wafula R, et al. Socio-economic and livestock disease survey of agro-pastoral communities in Serere County, Soroti District, Uganda. Livestock Research for Rural Development. 2005;17(8).
304. Ngom RRBV, Tomdieu T, Ziébé R, Foyet HS, Moritz M, Vondou L, et al. Quality of veterinary pharmaceuticals and their use by pastoralists in the Far North Region of Cameroon. Pastoralism. 2017;7(1):6.
305. Lamuka PO, Njeruh FM, Gitao GC, Abey KA. Camel health management and pastoralists' knowledge and information on zoonoses and food safety risks in Isiolo County, Kenya. Pastoralism. 2017;7(1):20.
306. Donovan C. Surveying the use of antimicrobials by pastoralists in Narok County, Kenya.
307. Higham L, Ongeri W, Asena K, Thrusfield M. Characterising and comparing drug-dispensing practices at animal health outlets in the Rift Valley, Kenya: an exploratory analysis (part II). Tropical animal health and production. 2016;48(8):1633-43.
308. Zezza A, Federighi G, Kalilou AA, Hiernaux P. Milking the data: Measuring milk off-take in extensive livestock systems. Experimental evidence from Niger. Food policy. 2016;59:174-86.
309. Diener E, Emmons RA, Larsen RJ, Griffin S. The satisfaction with life scale. Journal of personality assessment. 1985;49(1):71-5.
310. Schelling E, Bechir M, Ahmed MA, Wyss K, Randolph TF, Zinsstag J. Human and animal vaccination delivery to remote nomadic families, Chad. Emerging infectious diseases. 2007;13(3):373.

311. Slippers S, Letty B, De Villiers J. Prediction of the body weight of Nguni goats. South African Journal of Animal Science. 2000;30(4):127-8.
312. Atta M. Use of heart girth, wither height and scapuloischial length for prediction of liveweight of Nilotic sheep. Small Ruminant Research. 2004;55(1):233-7.
313. Lesosky M, Dumas S, Conradie I, Handel IG, Jennings A, Thumbi S, et al. A live weight–heart girth relationship for accurate dosing of east African shorthorn zebu cattle. Tropical animal health and production. 2012;45(1):311-6.
314. Yanda PZ, William C. Livelihoods diversifications and implications on food security and poverty levels in the Maasai plains: The case of Simanjiro district, Northern Tanzania. African Journal of Environmental Science and Technology. 2010;4(3).
315. Schellenberg JA, Victora CG, Mushi A, de Savigny D, Schellenberg D, Mshinda H, et al. Inequities among the very poor: health care for children in rural southern Tanzania. The Lancet. 2003;361(9357):561-6.
316. Kibutu TN. Development, gender and the crisis of masculinity among the Maasai people Ngong, Kenya: Geography; 2006.
317. Amutabi MN. Pastoralism, Social Protection and Vision 2030 in Kenya: Possibilities and Prospects.
318. Coppock DL, Tezera S, Eba B, Doyo J, Tadele D, Teshome D, et al. Sustainable Pastoralism in Ethiopia: Preliminary Results from Participatory Community Assessments on the North-central Borana Plateau. Research Brief. 2014.
319. Diener E. Understanding Scores on the Satisfaction with Life Scales 2006 [
320. Sachs J, Becchetti L, Annett A. World Happiness Report 2016, Special Rome Edition (Vol. II; intro., chapters I and III). New York: Sustainable Development Solutions Network. 2016.
321. Schensul JJ, LeCompte MD. Specialized ethnographic methods: A mixed methods approach: AltaMira Press; 2016.
322. Starks H, Brown Trinidad S. Choose your method: A comparison of phenomenology, discourse analysis, and grounded theory. Qualitative health research. 2007;17(10):1372-80.
323. Crookall GME. 2017 [
324. Weed DL. Underdetermination and incommensurability in contemporary epidemiology. Kennedy Institute of Ethics Journal. 1997;7(2):107-24.
325. Weed DL. Precaution, prevention, and public health ethics. The Journal of medicine and philosophy. 2004;29(3):313-32.
326. Stanford K. Underdetermination of scientific theory. 2009.
327. Hill AB. The environment and disease: association or causation? : SAGE Publications; 1965.
328. Fischer CT. Bracketing in qualitative research: Conceptual and practical matters. Psychotherapy Research. 2009;19(4-5):583-90.
329. Dyson-Hudson R, Dyson-Hudson N. Nomadic pastoralism. Annual review of anthropology. 1980;9(1):15-61.
330. Hodgson DL. Being Maasai, becoming indigenous: postcolonial politics in a neoliberal world: Indiana University Press; 2011.
331. Coast E. Maasai demography: University of London, University College London; 2001.
332. Holden T, Bourke L. Rural community wellbeing. Rural Society. 2014;23(3):208-15.

333. Yin R. Case study research design and methods (Fourth.). London: SAGE Publications Ltd; 2009.
334. Flyvbjerg B. Five misunderstandings about case-study research. Qualitative inquiry. 2006;12(2):219-45.
335. Yin RK. Enhancing the quality of case studies in health services research. Health services research. 1999;34(5 Pt 2):1209.
336. Bunch MJ, Waltner-Toews D. Grappling with Complexity: the Context for One Health and the Ecohealth Approach. One Health: The Theory and Practice of Integrated Health Approaches2015. p. 415.
337. Hobbes M. Stop trying to save the world: Big ideas are destroying international development. The New Republic. 2014;17.
338. Streb CK. Exploratory case studies. Encyclopedia of case study research. 2010:372-3.
339. Gustafson CR, VanWormer E, Kazwala R, Makweta A, Paul G, Smith W, et al. Educating pastoralists and extension officers on diverse livestock diseases in a changing environment in Tanzania. Pastoralism. 2015;5(1):1.
340. Punton M, Welle K. Applying process tracing in five steps. Brighton, UK: Institute of Development Studies. 2015.
341. Woolcock M. Using case studies to explore the external validity of 'complex'development interventions. Evaluation. 2013;19(3):229-48.
342. Smith K, Barrett CB, Box PW. Participatory risk mapping for targeting research and assistance: with an example from East African pastoralists. World Development. 2000;28(11):1945-59.
343. Mwangi M. Diverse Drought Spatiotemporal Trends, Diverse Etic-Emic Perceptions and Knowledge: Implications for Adaptive Capacity and Resource Management for Indigenous Maasai-Pastoralism in the Rangelands of Kenya. Climate. 2016;4(2):22.
344. Farnworth CR, Baudron F, Andersson JA, Misiko M, Badstue L, Stirling CM. Gender and conservation agriculture in East and Southern Africa: towards a research agenda. International Journal of Agricultural Sustainability. 2016;14(2):142-65.
345. UNDP. Marginalised minorities in development programming: A UNDP resource guide and toolkit. 2010.
346. Wallerstein N, Duran B. Community-based participatory research contributions to intervention research: the intersection of science and practice to improve health equity. American journal of public health. 2010;100(S1):S40-S6.
347. Niamir-Fuller M, Kerven C, Reid R, Milner-Gulland E. Co-existence of wildlife and pastoralism on extensive rangelands: competition or compatibility? Pastoralism. 2012;2(1):1-14.
348. Acharya GD. Including the excluded: Marginalised poor communities and development practices in rural Nepal. Queensland, Australia: The University of Queensland 2018.
349. Kabeer N. Social exclusion, poverty and discrimination towards an analytical framework. IDS bulletin. 2000;31(4):83-97.
350. Rauch T, Beckmann G, Neubert S, Rettberg S. Rural Transformation in Sub-Saharan Africa: Conceptual Study. SLE Discussion Paper; 2016.
351. Elwan A. Poverty and disability: A survey of the literature: Social Protection Advisory Service Washington, DC; 1999.

352. ACPF. Children with disabilities in South Africa: The hidden reality. 2011.
353. Donald KA, Samia P, Kakooza-Mwesige A, Bearden D, editors. Pediatric cerebral palsy in Africa: a systematic review. Seminars in Pediatric Neurology; 2014: Elsevier.
354. Rohwerder B. Disability stigma in developing countries. 2018.
355. Horton R. Medical journals: evidence of bias against the diseases of poverty. The Lancet. 2003;361(9359):712.
356. Miranda JJ, Zaman MJ. Exporting" failure": why research from rich countries may not benefit the developing world. Revista de saúde pública. 2010;44(1):185-9.
357. Sherman DM. Animal Agriculture and Food Production Worldwide. Tending Animals in the Global Village: A Guide to International Veterinary Medicine. 2005:74-123.
358. Pilling D, Heffernan C, editors. Livestock disease prioritisation for poverty alleviation2003: International Symposia for Veterinary Epidemiology and Economics (ISVEE).
359. Birch I, Grahn R. Pastoralism–managing multiple stressors and the threat of climate variability and change. UNDP Human Development Report Office Occasional Paper, UNDP: New York. 2007.
360. Wong G, Westhorp G, Manzano A, Greenhalgh J, Jagosh J, Greenhalgh T. RAMESES II reporting standards for realist evaluations. BMC medicine. 2016;14(1):96.
361. Westhorp G. Realist impact evaluation: an introduction. London: Overseas Development Institute. 2014:1-12.
362. Pawson R, Tilley N. 3: In with the New: Introducing Scientific Realism. Realistic Evaluation London: Sage Publications. 1997:55-92.
363. Paterson C, Baarts C, Launsø L, Verhoef MJ. Evaluating complex health interventions: a critical analysis of the'outcomes' concept. BMC Complementary and Alternative Medicine. 2009;9(1):18.
364. Galaty JG. Being "People-of-Cattle": Ethnic Shifters in East Africa. American Ethnologist. 1982;9(1):1-20

365. Grandin BE. The Maasai: Socio-historical context and group ranches. Maasai Herding: An Analysis of the Livestock Production System of Maasai Pastoralists in Eastern Kajiado District, Kenya ILCA: Addis Ababa, Ethiopia. 1991:21-39.
366. Rutten MMEM. Selling wealth to buy poverty: the process of the individualization of landownership among the Maasai pastoralists of Kajiado district, Kenya, 1890-1990: Breitenbach, Saarbrücken [etc.]; 1992.
367. Bruner EM, Kirshenblatt-Gimblett B. Maasai on the lawn: Tourist realism in East Africa. Cultural Anthropology. 1994;9(4):435-70.
368. Galaty JG. Maasai expansion and the new East African pastoralism. Being Maasai: ethnicity and identity in East Africa. 1993:61-86.
369. Holland K. The Maasai on the horns of a dilemma: development and education. 1996.
370. Hughes L. Malice in Maasailand: The historical roots of current political struggles. African Affairs. 2005;104(415):207-24.
371. Wangui EE. Development interventions, changing livelihoods, and the making of female Maasai pastoralists. Agriculture and human values. 2008;25(3):365-78.
372. Switzer HD. Making the Maasai Schoolgirl: Developing Modernities on the Margins. 2009.

373. Bachar M. The Maasai's perception of female education and Maasai girls' perception of their educational experiences in Kajiado, Kenya. 2012.
374. Lemaron R. Community and Institutional Factors Influencing Access to Antenatal Healthcare Services by Maasai Women in Isinya, Kajiado County: University of Nairobi; 2016.
375. Hodgson D. Images and interventions: The problems of pastoralist development. The Poor Are Not Us: Poverty and Pastoralism in East Africa, James Currey, London. 1999:221-39.
376. Hodgson DL. Once intrepid warriors: Gender, ethnicity, and the cultural politics of Maasai development: Indiana University Press; 2001.
377. Hodgson DL. Africa from the Margins. African Studies Review. 2017;60(2):37-49.
378. Hodgson DL. "Once Intrepid Warriors": Modernity and the Production. Gendered Modernities: Ethnographic Perspectives. 2016:105.
379. Presbey GM. Maasai Rejection of the Western Paradigm of Development: A Foucaultian Analysis. Social Philosophy Today. 2000;15:339-59.
380. Kotowicz AM. Maasai Identity in the 21st Century. 2013.
381. Commission LVB. Serengeti-Maasai Mara Ecosystem Transboundary Protection and Monitoring Plan. Lake Victoria Basin Commission; 2012.
382. Leal Filho W, Nzengya D, Muasya G, Chemuliti J, Kalungu JW. Climate change responses among the Maasai Community in Kenya. Climatic change. 2017;145(1-2):71-83.
383. Bobadoye A, Ogara W, Ouma G, Onono J. Pastoralist perceptions on climate change and variability in Kajiado in relation to meteorology evidence. Academic Journal of Interdisciplinary Studies. 2016;5(1):37.
384. Herrero M, Addison J, Bedelian C, Carabine E, Havlík P, Henderson B, et al. Climate change and pastoralism: impacts, consequences and adaptation. Rev Sci Tech. 2016;35:417-33.
385. Bedelian C, Ogutu JO. Trade-offs for climate-resilient pastoral livelihoods in wildlife conservancies in the Mara ecosystem, Kenya. Pastoralism. 2017;7(1):10.
386. Enström S, Nthiwa D, Bett B, Karlsson A, Alonso S, Lindahl JF. Brucella seroprevalence in cattle near a wildlife reserve in Kenya. BMC research notes. 2017;10(1):615.
387. Lankester F, Lugelo A, Kazwala R, Keyyu J, Cleaveland S, Yoder J. The economic impact of malignant catarrhal fever on pastoralist livelihoods. PloS one. 2015;10(1):e0116059.
388. Shilaho WK. Political Power and Tribalism in Kenya: Springer; 2017.
389. Bunei EK, Rono JK. A Critical Understanding of Resistance to Criminalization of Female Genital Mutilation in Kenya. The Palgrave Handbook of Criminology and the Global South: Springer; 2018. p. 901-12.
390. Pakdamana SaA, B. Maasai Culture and its Effect on Sexual Health: A Field Study on the Disparities of Knowledge Within the Community. The Journal of Public Health. 2014.
391. Archambault CS. Ethnographic empathy and the social context of rights:"Rescuing" Maasai girls from early marriage. American anthropologist. 2011;113(4):632-43.
392. Coast E. Maasai marriage: a comparative study of Kenya and Tanzania. Journal of comparative family studies. 2006:399-419.

393. Archambault CS. 'The pen is the spear of today':(re) producing gender in the Maasai schooling setting. Gender and Education. 2017;29(6):731-47.
394. May A, McCabe JT. City work in a time of AIDS: Maasai labor migration in Tanzania. Africa Today. 2004:3-32.
395. Hauck S, Rubenstein DI. Pastoralist societies in flux: A conceptual framework analysis of herding and land use among the Mukugodo Maasai of Kenya. Pastoralism. 2017;7(1):18.
396. Olol-Dapash M. Maasai autonomy and sovereignty in Kenya and Tanzania. Cultural Survival Quarterly. 2001;25(1):30.
397. Verma R. Land grabs, power, and gender in East and Southern Africa: So, what's new? Feminist Economics. 2014;20(1):52-75.
398. Kameri-Mbote P. Women, land rights and the environment: the Kenyan experience. Development. 2006;49(3):43-8.
399. Goldman MJ, Davis A, Little J. Controlling land they call their own: access and women's empowerment in Northern Tanzania. The Journal of Peasant Studies. 2016;43(4):777-97.
400. Kipuri N, Ridgewell A. A double bind: the exclusion of pastoralist women in the East and Horn of Africa: Citeseer; 2008.
401. Dancer H. An equal right to inherit? Women's land rights, customary law and constitutional reform in Tanzania. Social & Legal Studies. 2017;26(3):291-310.
402. Scalise E. Indigenous Women's Land Rights: Case Studies from Africa. State of the World's Minorities and Indigenous Peoples 2012. 2012:53-9.
403. Hodgson DL. The church of women: gendered encounters between Maasai and missionaries: Indiana University Press; 2005.
404. Warrington M, Kiragu S. "It makes more sense to educate a boy": Girls 'against the odds' in Kajiado, Kenya. International journal of educational development. 2012;32(2):301-9.
405. Ngumbi EK. Educational experiences of young Maasai women in Kajiado District, Kenya: A phenomenological case study of Enoomatasiani Girls Secondary School: Ohio University; 2011.
406. Memiah P, Ah Mu T, Prevot K, Cook CK, Mwangi MM, Mwangi EW, et al. The prevalence of intimate partner violence, associated risk factors, and other moderating effects: findings from the Kenya National Health Demographic Survey. Journal of interpersonal violence. 2018:0886260518804177.
407. Goldman MJ, Little JS. Innovative grassroots NGOS and the complex processes of women's empowerment: An empirical investigation from Northern Tanzania. World Development. 2015;66:762-77.
408. Okiya DO. The Centrality of Marriage in African Religio-Culture with Reference to the Maasai of Kajiadi County, Kenya: Kenyatta University; 2016.
409. Toth R. Traps and thresholds in pastoralist mobility. American Journal of Agricultural Economics. 2015;97(1):315.
410. Toulmin C. Livestock losses and post-drought rehabilitation in sub-Saharan Africa. 1985.
411. Barton D, Meadows N, Morton J. Drought losses, pastoral saving and banking: a review. Natural Resources Institute. 2001.

412. Hodgson DL. Pastoralism, patriarchy and history: Changing gender relations among Maasai in Tanganyika, 1890–1940. The Journal of African History. 1999;40(01):41-65.
413. Hakansson T. Family structure, bridewealth, and environment in Eastern Africa: a comparative study of house-property systems. Ethnology. 1989;28(2):117-34.
414. 2014 KDHS Key Findings. National Bureau of Statistics-Kenya and ICF International2015.
415. Askew I, Maggwa N, Obare F. Fertility Transitions in Ghana and Kenya: Trends, Determinants, and Implications for Policy and Programs. Population and Development Review. 2017;43(S1):289-307.
416. Sindiga I. Fertility control and population growth among the Maasai. Human ecology. 1987;15(1):53-66.
417. Makinwa-Adebusoye P. Sociocultural factors affecting fertility in sub-Saharan Africa. Prospects for Fertility Decline in High Fertility Countries, Population Bulletin of the United Nations, Special Issue Nos 46. 2007;47:55-69.
418. Mkonyi FJ, Estes AB, Msuha MJ, Lichtenfeld LL, Durant SM. Fortified Bomas and Vigilant Herding are Perceived to Reduce Livestock Depredation by Large Carnivores in the Tarangire-Simanjiro Ecosystem, Tanzania. Human Ecology. 2017;45(4):513-23.
419. Gimbo R, Mujawamariya N, Saunders S. Why Maasai parents enroll their children in primary school: the case of Makuyuni in Northern Tanzania. Interdisciplinary Journal of Best Practices in Global Development. 2015;1(1):5.
420. Jandreau C, Berkes F. Continuity and change within the social-ecological and political landscape of the Maasai Mara, Kenya. Pastoralism. 2016;6(1):1.
421. Bonini N. The pencil and the shepherd's crook. Ethnography of Maasai education. Ethnography and Education. 2006;1(3):379-82.
422. Yao Y. Traditional vs. modernity: an exploratory study of the Impact of the colonial education system among Maasai children in Laiboni village, Tanzania. 2018.
423. Hedges S, Mulder MB, James S, Lawson DW. Sending children to school: rural livelihoods and parental investment in education in northern Tanzania. Evolution and human behavior. 2016;37(2):142-51.
424. Parsitau DS. Engaging the Custodians of Tradition and Culture. 2017.
425. AFIDEP. Adolescent Sexual and Reproductive Health in Narok County. In: Health Mo, editor. OnlineN.D.
426. Roulette JW, Roulette CJ, Quinlan RJ, Call DR, Hewlett BS, Caudell MA, et al. Children's Ethnobiological Notions of Contamination and Contagions among Maasai Agro-Pastoralists of Northern Tanzania. Journal of Ethnobiology. 2018;38(2):261-75.
427. Saitoti TO. The worlds of a Maasai warrior: An autobiography: Univ of California Press; 1988.
428. Coast E. Maasai socioeconomic conditions: a cross-border comparison. Human ecology. 2002;30(1):79-105.
429. Aikman S. Educational and indigenous justice in Africa. International Journal of Educational Development. 2011;31(1):15-22.
430. Buzinde CN, Kalavar JM, Melubo K. Tourism and community well-being: The case of the Maasai in Tanzania. Annals of Tourism Research. 2014;44:20-35.
431. Sankok JaN, J. Interview with CMF administrators. 2008.

432. Unknown. Official Kenyan Government Website Health: Kenyatta National Hospital. N.A.
433. Rigby P. Pastors and pastoralists: the differential penetration of Christianity among East African cattle herders. Comparative Studies in Society and History. 1981;23(01):96-129.
434. Machira MaO, Dominic. Here's Why You Always Feel Poorer. Standard (digital). 2017 April 19th.
435. Christiaensen L, Demery L, Kuhl J. The (evolving) role of agriculture in poverty reduction—An empirical perspective. Journal of development economics. 2011;96(2):239-54.
436. Otte J, Pica-Ciamarra U, Ahuja V, Gustafson D. Supporting Livestock Sector Development for Poverty Reduction: Issues and Proposals. Pro-Poor Livestock Policy Initiative (PPLPI) Research Report (FAO). 2009.
437. Chant S. The 'feminisation of poverty'and the 'feminisation'of anti-poverty programmes: Room for revision? The Journal of Development Studies. 2008;44(2):165-97.
438. Quisumbing AR, Meinzen-Dick R, Raney TL, Croppenstedt A, Behrman JA, Peterman A. Closing the knowledge gap on gender in agriculture. Gender in Agriculture: Springer; 2014. p. 3-27.
439. Thornton P, Kruska R, Henninger N, Kristjanson P, Reid R, Robinson T. Locating poor livestock keepers at the global level for research and development targeting. Land Use Policy. 2003;20(4):311-22.
440. FAO. Women in agriculture: closing the gender gap for development 2012.
441. Parsons I, Lombard M. The power of women in dairying communities of eastern and southern Africa. Azania: Archaeological Research in Africa. 2017;52(1):33-48.
442. Guyo FB. Colonial and post-colonial changes and impact on pastoral women's roles and status. Pastoralism. 2017;7(1):13.
443. Koehler-Rollefson I. Purdah, purse and patriarchy: The position of women in the Raika shepherd community in Rajasthan (India). Journal of Arid Environments. 2018;149:30-9.
444. Galaty JG. Land and Livestock among Kenyan Masai: Symbolic Perspectives on Pastoral Exchange, Change and Inequality. Journal of Asian and African Studies. 1981;16(1):68.
445. Alessandra G, Distefano F, Kangogo D, Mattioli RC, Wieland B, Baltenweck I. Gendered perspectives on smallholder cattle production and health management in three sites in Tanzania. 2017.
446. Team S. Gender differences in assets. ESA Working Paper; 2011.
447. Watson C. Gender Issues and Pastoral Economic Growth and Development in Ethiopia. UK Department for International Development (DFID) & Government of Ethiopia: Addis Ababa. 2010.
448. Downie K. A review of good practice and lessons learned in programming for ASAL populations in the Horn of Africa. For UNICEF ESARO. Available http://www. disasterriskreduction. net/djibouti/documentation/detail/en; 2011.
449. Anderson D, Broch-Due V. The poor are not us: poverty & pastoralism in Eastern Africa. Nairobi; Oxford; Athens: J. Currey; 1999.

450. Fratkin E, Mearns R. Sustainability and pastoral livelihoods: lessons from East African Maasai and Mongolia. Human organization. 2003;62(2):112-22.
451. Lesorogol CK. Transforming institutions among pastoralists: inequality and land privatization. American Anthropologist. 2003;105(3):531-41.
452. Lesorogol C, Chowa G, Ansong D. Livestock or the pen: The effects of inheritance and education on poverty among pastoralists. Chronic Poverty Research Centre Working Paper. 2011(188).
453. Ali A, Hobson M. Social protection in pastoral areas. Humanitarian Policy Group Overseas Development Institute, London. 2009.
454. Heffernan C, Miturelli F, Nielsen L. Restocking and poverty alleviation: perceptions and realities of livestock-keeping among poor pastoralists in Kenya. 2001.
455. Stotsky JG. Gender and its relevance to macroeconomic policy: A survey. IMF Working Papers. 2006:1-68.
456. Kehler J. Women and poverty: the South African experience. Journal of International Women's Studies. 2001;3(1):41-53.
457. Marweg AC. International development in two rural Kenyan villages: a transnational feminist approach. 2007.
458. Randall S, Coast E. Poverty in African households: the limits of survey and census representations. The Journal of Development Studies. 2015;51(2):162-77.
459. Kahn K, Tollman SM, Collinson MA, Clark SJ, Twine R, Clark BD, et al. Research into health, population and social transitions in rural South Africa: Data and methods of the Agincourt Health and Demographic Surveillance System1. Scandinavian Journal of Public Health. 2007;35(69 suppl):8-20.
460. Buvinic M. The missing workers: Women in the rural economies in LAC (Latin American Countries). 1999.
461. Hesse C, Odhiambo MO, editors. Strengthening pastoralists' voice in shaping policies for sustainable poverty reduction in ASAL regions of East Africa. Conference on Pastoralism and poverty reduction in East Africa; 2006.
462. Ho P, Azadi H. Rangeland degradation in North China: perceptions of pastoralists. Environmental Research. 2010;110(3):302-7.
463. Sadler K, Kerven C, Calo M, Manske M, Catley A. The fat and the lean: a review of production and use of milk by pastoralists. Pastoralism. 2010;1(2):291-324.
464. Behrman JA, Meinzen-Dick R, Quisumbing AR. Understanding gender and culture in agriculture: the role of qualitative and quantitative approaches. Gender in Agriculture: Springer; 2014. p. 31-53.
465. Ransom E, Bain C. Gendering agricultural aid an analysis of whether international development assistance targets women and gender. Gender & Society. 2011;25(1):48-74.
466. Carr ER, Thompson MC. Gender and Climate Change Adaptation in Agrarian Settings: Current Thinking, New Directions, and Research Frontiers: Gender and Climate Change Adaptation in Agrarian Settings. Geography Compass. 2014;8(3):182-97.
467. U.N. Gender mainstreaming: an overview. New York U6 - ctx_ver=Z39.88-2004&ctx_enc=info%3Aofi%2Fenc%3AUTF-8&rfr_id=info:sid/summon.serialssolutions.com&rft_val_fmt=info:ofi/fmt:kev:mtx:journal&rft.genre=article&rft.atitle=Gender+mainstreaming&rft.date=2002-01-01&rft.pub=United+Nations%2C+Office+of+the+Special+Adviser+on+Gender+Issues+and

+Advancement+of+Women&rft.externalDocID=2601454&paramdict=en-US U7 - Government Document: United Nations, Office of the Special Adviser on Gender Issues and Advancement of Women; 2002. Contract No.: Report.
468. Hurni H, Osman-Elasha B, Barnett A, Herbert A, Idel A, Kairo M, et al. Context, conceptual framework and sustainability indicators. International Water Management Institute; 2009.
469. ILRI. Agricultural research, climate change and 'social learning': How did we get here? 2013 [cited 2016 12/5/2016]. Available from: http://www.ilri.org/ilrinews/index.php/archives/tag/philip-thornton.
470. Livingstone J, Ruhindi E. Women and economic diversification in pastoralist societies. Pastoralism and Development in Africa: Dynamic Change at the Margins. 2012;231.
471. Diener E, Kahneman D, Helliwell J. International differences in well-being: Oxford University Press; 2010.
472. Diener E. The Remarkable Changes in the Science of Subjective Well-Being. Perspectives on Psychological Science. 2013;8(6):663-6.
473. White SC, Gaines Jr SO, Jha S. Inner Wellbeing: Concept and Validation of a New Approach to Subjective Perceptions of Wellbeing—India. Social indicators research. 2014;119(2):723-46.
474. Krämer W. Sabina Alkire, James Foster, Suman Seth, Maria Emma Santos, José Manuel Roche and Paola Ballon: Multidimensional poverty measurement and analysis: Oxford University Press, Oxford, UK, 2015, 368 pp., £35.00, ISBN 978-0-19-968949-1. Statistical Papers. 2015.
475. White SC. Bringing wellbeing into development practice. 2009.
476. Fletschner D, Kenney L. Rural women's access to financial services: credit, savings, and insurance. Gender in agriculture: Springer; 2014. p. 187-208.
477. Ellis F. Rural livelihoods and diversity in developing countries: Oxford university press; 2000.
478. Douthwaite B, Schulz S, Olanrewaju AS, Ellis-Jones J. Impact pathway evaluation of an integrated Striga hermonthica control project in Northern Nigeria. Agricultural systems. 2007;92(1-3):201-22.
479. Ajagbe F. Analysis of Access to and Demand for Credit by Small Scale Entrepreneurs; Evidence from Oyo State, Nigeria. Journal of Emerging Trends in Economics and Management Sciences. 2012;3(3):180.
480. Mpuga P. Constraints in access to and demand for rural credit: Evidence from Uganda. African Development Review. 2010;22(1):115-48.
481. Quisumbing AR, Maluccio JA. Intrahousehold allocation and gender relations: New empirical evidence from four developing countries: International Food Policy Research Institute Washington, DC; 2000.
482. Robinson J. Limited insurance within the household: evidence from a field experiment in Kenya. Available at SSRN 1282231. 2008.
483. Buvinić M, Gupta GR. Female-Headed Households and Female-Maintained Families: Are They Worth Targeting to Reduce Poverty in Developing Countries? Economic Development and Cultural Change. 1997;45(2):259-80.

484. Chant S. Women-Headed Households: Poorest of the Poor?: Perspectives from Mexico, Costa Rica and the Philippines1. IDS bulletin. 1997;28(3):26-48.
485. Momsen JH. Myth or math: the waxing and waning of the female-headed household. Progress in Development Studies. 2002;2(2):145-51.
486. Quisumbing AR, Haddad L, Peña C. Are women overrepresented among the poor? An analysis of poverty in 10 developing countries. Journal of Development Economics. 2001;66(1):225-69.
487. Appleton S. Women-headed households and household welfare: an empirical deconstruction for Uganda. World Development. 1996;24(12):1811-27.
488. Lansford JE, Ceballo R, Abbey A, Stewart AJ. Does family structure matter? A comparison of adoptive, two-parent biological, single-mother, stepfather, and stepmother households. Journal of Marriage and family. 2001;63(3):840-51.
489. Fuwa N. The poverty and heterogeneity among female-headed households revisited: the case of Panama. World Development. 2000;28(8):1515-42.
490. Lloyd CB, Blanc AK. Children's Schooling in sub-Saharan Africa: The Role of Fathers, Mothers, and Others. Population and Development Review. 1996;22(2):265-98.
491. Fuller B, Liang X. Which girls stay in school. The influence of family. 1999.
492. Blackden CM, Open Knowledge R. Gender, Growth, and Poverty Reduction1999.
493. Horrell S, Krishnan P. Poverty and productivity in female-headed households in Zimbabwe. The Journal of Development Studies. 2007;43(8):1351-80.
494. Musangi P. Women Land and Property Rights in Kenya. 2017.
495. KLA. Kenya Land Issuance: Disaggregated Data Analysis. 2018.
496. van Ingen E. Legal Pluralities and Interlegality in Tanzania: Maasai Women's Property Rights. 2014.
497. Vieira Lima S. A cross-country investigation of the determinants of the happiness gender gap. Downloaded Jan. 2011;14:2014.
498. Deaton A, Fortson J, Tortora R. Life (evaluation), HIV/AIDS, and death in Africa. National Bureau of Economic Research; 2009.
499. Graham C, Chattopadhyay S. Gender and well-being around the world. International Journal of Happiness and Development. 2013;1(2):212-32.
500. Zweig JS. Are women happier than men? Evidence from the Gallup World Poll. Journal of Happiness Studies. 2015;16(2):515-41.
501. Stevenson B, Wolfers J. The Paradox of Declining Female Happines. American Economic Journal: Economic Policy. 2009;1(2):190-225.
502. Meisenberg G, Woodley MA. Gender differences in subjective well-being and their relationships with gender equality. Journal of Happiness Studies. 2015;16(6):1539-55.
503. CCCIC. A Review of CIDA's Countries of Priorities: A CCIC Briefing Note 2009 February 2009.
504. MØLLER V, ROBERTS BJ, TILIOUINE H, LOSCHKY J. 'WAITING FOR HAPPINESS'IN AFRICA1. WORLD HAPPINESS REPORT 2017. 2017:84.
505. Salazar NB. Tourism imaginaries: A conceptual approach. Annals of Tourism research. 2012;39(2):863-82.
506. Biswas-Diener R. From the equator to the North Pole: A study of character strengths. Journal of Happiness Studies. 2006;7(3):293-310.

507. Diener E, Diener M. Cross-Cultural Correlates of Life Satisfaction and Self-Esteem. Journal of Personality and Social Psychology. 1995;68(4):653-63.
508. Diener E, Tay L. Subjective well-being and human welfare around the world as reflected in the Gallup World Poll. International Journal of Psychology. 2015;50(2):135-49.
509. Glatzer W. Rich and poor: Disparities, perceptions, concomitants: Springer Science & Business Media; 2002.
510. de Hoop T, van Kempen L, Linssen R, van Eerdewijk A. Women's autonomy and subjective well-being: how gender norms shape the impact of self-help groups in Odisha, India. Feminist economics. 2014;20(3):103-35.
511. Duflo E. Women empowerment and economic development. Journal of Economic Literature. 2012;50(4):1051-79.
512. Spencer P. The Maasai of Matapato: A study of rituals of rebellion: Routledge; 2004.
513. Pavot WaDE. The Satisfaction with Life Scale (SWL) 2013 [Available from: http://www.midss.org/sites/default/files/understanding_swls_scores.pdf.
514. Joireman SF. The mystery of capital formation in Sub-Saharan Africa: women, property rights and customary law. World Development. 2008;36(7):1233-46.
515. Heffernan C. Panzootics and the poor: devising a global livestock disease prioritisation framework for poverty alleviation. Revue scientifique et technique. 2009;28(3):897.
516. Improved animal health for poverty reduction and sustainable livelihoods. Rome: Food and Agriculture Organization of the United Nations : Emergency Prevention System; 2002.
517. Upton M. The role of livestock in economic development and poverty reduction. Pro-Poor Livestock Policy Initiative Working Paper. 2004;10:1-57.
518. Pradère JP. Improving animal health and livestock productivity to reduce poverty. Revue scientifique et technique (International Office of Epizootics). 2014;33(3):735.
519. de Haan C. Livestock development: implications for rural poverty, the environment, and global food security: World Bank Publications; 2001.
520. Otte J. Livestock sector development for poverty reduction. Rome: Food and Agricultural Organization of the United Nations; 2012.
521. Waters-Bayer A, Bayer W, editors. Pastoralists in the 21st century:'Lo-Tech'meets' Hi-tech'. Saskatoon, SK: 10th International Rangeland Congress; 2016.
522. Chupin D, Schuh H. Survey of present status of the use of artificial insemination in developing countries. World Animal Review. 1993;74(75):26-35.
523. Kahi A, Rewe T. Biotechnology in livestock production: Overview of possibilities for Africa. African Journal of Biotechnology. 2008;7(25).
524. KENYA G. Kenya Veterinary Policy (draft). Nairobi: Available at: http://www kilimo go ke/wp-content/uploads/2015/06/Draft-Veterinary-Policy pdf [Accessed]. 2015.
525. Barrett CB, Bezuneh M, Aboud A. Income diversification, poverty traps and policy shocks in Côte d'Ivoire and Kenya. Food Policy. 2001;26(4):367-84.
526. Mellor JW, Malik SJ. The impact of growth in small commercial farm productivity on rural poverty reduction. World Development. 2017;91:1-10.
527. FAO. The State of Food and Agriculture 2016. Available from: http://www.fao.org/3/a-i6030e.pdf.

528. Njuki J, Sanginga PC. Women, livestock ownership and markets: Bridging the gender gap in eastern and southern Africa: Routledge; 2013.
529. Swai E, Mbise A, Kessy V, Kaaya E, Sanka P, Loomu P. Farm constraints, cattle disease perception and tick management practices in pastoral Maasai community-Ngorongoro, Tanzania. Livestock Research for Rural Development. 2005;17(2).
530. Abdilatif MH, Onono JO, Mutua FK. Analysis of pastoralists' perception on challenges and opportunities for sheep and goat production in Northern Kenya. Tropical animal health and production. 2018:1-10.
531. Muricho DN, Otieno DJ, Oluoch-Kosura W. Building Pastoralists' Resilience: Strengthening Participation in Markets and Local Governance Institutions in West Pokot, Kenya. 2017.
532. Onono JO, Wieland B, Rushton J. Constraints to cattle production in a semiarid pastoral system in Kenya. Tropical animal health and production. 2013;45(6):1415-22.
533. Njuki J, Mburu S. Gender and ownership of livestock assets. WOMEN, LIVESTOCK OWNERSHIP AND MARKETS. 2013:21.
534. Flintan F. Women's empowerment in pastoral societies. WISP, GEF, IUCN, UNDP. 2008.
535. Adenle AA, Azadi H, Manning L. The era of sustainable agricultural development in Africa: Understanding the benefits and constraints. Food reviews international. 2018;34(5):411-33.
536. Wyche S, Steinfield C. Why don't farmers use cell phones to access market prices? technology affordances and barriers to market information services adoption in rural Kenya. Information Technology for Development. 2016;22(2):320-33.
537. Mwamakamba SN, Sibanda LM, Pittock J, Stirzaker R, Bjornlund H, van Rooyen A, et al. Irrigating Africa: Policy barriers and opportunities for enhanced productivity of smallholder farmers. International journal of water resources development. 2017;33(5):824-38.
538. Little PD. A victory in theory, loss in practice: struggles for political representation in the Lake Baringo-Bogoria Basin, Kenya. Journal of Eastern African Studies. 2016;10(1):189-207.
539. Devereux S, Tibbo K. Social protection for pastoralists. Pastoralism and development in Africa: Dynamic change at the margins. 2013:215.
540. Caudell MA, Quinlan MB, Subbiah M, Call DR, Roulette CJ, Roulette JW, et al. Antimicrobial use and veterinary care among agro-pastoralists in northern Tanzania. PloS one. 2017;12(1):e0170328.
541. Chanamuto NJ, Hall SJ. Gender equality, resilience to climate change, and the design of livestock projects for rural livelihoods. Gender & Development. 2015;23(3):515-30.
542. FAO. Shaping the future of livestock sustainably, responsibly, efficiently. 2018.
543. Dumas SE, Maranga A, Mbullo P, Collins S, Wekesa P, Onono M, et al. "Men Are in Front at Eating Time, but Not When It Comes to Rearing the Chicken": Unpacking the Gendered Benefits and Costs of Livestock Ownership in Kenya. Food and nutrition bulletin. 2017:0379572117737428.
544. Furusa Z, Furusa M. Women's coping and adaptation capacities in pastoralist communities in Africa: Dealing with climate variability and change. Agenda. 2014;28(3):65-72.

545. BurnSilver S. Representing wealth in a changing pastoral economy: a comparison of traditional and new metrics in Maasailand, Kenya. Nomadic Peoples. 2016;20(1):8-34.
546. Sieff DF. The effects of wealth on livestock dynamics among the Datoga pastoralists of Tanzania. Agricultural systems. 1999;59(1):1-25.
547. Bekure S. Maasai herding: an analysis of the livestock production system of Maasai pastoralists in eastern Kajiado District, Kenya: ILRI (aka ILCA and ILRAD); 1991.
548. Smith J, Sones K, Grace D, MacMillan S, Tarawali S, Herrero M. Beyond milk, meat, and eggs: Role of livestock in food and nutrition security. Animal Frontiers. 2013;3(1):6-13.
549. Fentie T. Assessment of young livestock mortality in major livestock production systems of Ethiopia. 2016.
550. Demille JL. In search of nation: The political identity and social mobilization of Kenya's Maasai: Indiana University; 2013.
551. Letoluo ML, Wangombe L. Exploring the Socio-economic Effects of the Community Tourism Fund to the Local Community, Maasai Mara National Reserve. Universal Journal of Management. 2018;6(2):51-8.
552. Lewis AE. Amboseli landscapes: Maasai pastoralism, wildlife conservation, and natural resource management in Kenya, 1944-present: Michigan State University; 2015.
553. Anderson DM. Cow power: Livestock and the pastoralist in Africa. African Affairs. 1993;92(366):121-33.
554. Kinyenze JM, Irungu C. An analysis of the social and economic effects of land tenure practices among the Maasai Community in Ngong Division, Kajiado County, Kenya. African Multidisciplinary Journal of Research. 2017;1(1).
555. Galaty JG. 20 Cattle and cognition: aspects of Maasai practical reasoning. The walking larder: patterns of domestication, pastoralism, and predation. 1989;2:215.
556. Galaty JG. The indigenisation of pastoral modernity: territoriality, mobility, and poverty in Dryland Africa. Pastoralism in Africa: past, present, and future New York: Berghahn. 2013:473-510.
557. Barrett C, Smith K, Box P. Not necessarily in the same boat: Heterogeneous risk assessment among East African pastoralists. Journal of Development Studies. 2001;37(5):1-30.
558. McKune SL, Borresen EC, Young AG, Ryley TDA, Russo SL, Camara AD, et al. Climate change through a gendered lens: Examining livestock holder food security. Global Food Security. 2015;6:1-8.
559. Mahanjana A, Cronje P. Factors affecting goat production in a communal farming system in the Eastern Cape region of South Africa. South African Journal of Animal Science. 2000;30(2):149-55.
560. Rutten MMEM. Why De Soto's land-tenure ideas of formalized property rights are failing to benefit Africa's poor. 2009.
561. Hodgson DL. Women as children: Culture, political economy, and gender inequality among Kisongo Maasai. Nomadic peoples. 1999:115-30.
562. Doss C, Grown C, Deere CD. Gender and asset ownership: a guide to collecting individual-level data. 2008.
563. Weesie R, Kronenburg García A. From Herding to Farming under Adaptation Interventions in Southern Kenya: A Critical Perspective. Sustainability. 2018;10(12):4386.

564. Bersaglio B, Devlin J, Yap N. Contextualising emergency responses to famine among Turkana pastoralists in Kenya. Development in Practice. 2015;25(5):688-702.
565. Ochieng F, Wanjihia C, Leclert LM. Building community WASH resilience: the case study of a rock catchment system in Marsabit County, Kenya. 2018.
566. Pertet AS, Yeomans J. Sustainable agriculture microfinance based on agricultural limitations of the maasai in Kajiado Country, Kenya. 2016.
567. Twine EE, Githinji J, Nandonde S, Mkwama N, Mushi A, Mihayo E. Site-specific plans for the More Milk in Tanzania project, Morogoro region. 2017.
568. Majekodunmi AO, Dongkum C, Langs T, Shaw A, Welburn S. Improved productivity and sustainable pastoral systems in an era of insecurity—Fulani herds of the southern Jos Plateau, North-Central Nigeria. Tropical animal health and production. 2016;48(8):1719-28.
569. Desta AH. Major Constraints of Veterinary Services Delivery System and Its Solution in Pastoral Areas of Ethiopia. International Journal of African and Asian Studies. 2015;12(1):5-11.
570. Bugeza J, Kankya C, Muleme J, Akandinda A, Sserugga J, Nantima N, et al. Participatory evaluation of delivery of animal health care services by community animal health workers in Karamoja region of Uganda. PloS one. 2017;12(6):e0179110.
571. Ilukor J. Improving the delivery of veterinary services in Africa: insights from the empirical application of transaction costs theory in Uganda and Kenya. Revue scientifique et technique (International Office of Epizootics). 2017;36(1):279-89.
572. Kermode M, Morgan A, Nyagero J, Nderitu F, Caulfield T, Reeve M, et al. Walking Together: Towards a Collaborative Model for Maternal Health Care in Pastoralist Communities of Laikipia and Samburu, Kenya. Maternal and child health journal. 2017;21(10):1867-73.
573. Valdivia C. Gender, livestock assets, resource management, and food security: lessons from the SR-CRSP. Agriculture and human values. 2001;18(1):27-39.
574. Byaruhanga C, Oosthuizen MC, Collins NE, Knobel D. Using participatory epidemiology to investigate management options and relative importance of tick-borne diseases amongst transhumant zebu cattle in Karamoja region, Uganda. Preventive veterinary medicine. 2015;122(3):287-97.
575. Holt H, Selby R, Mumba C, Napier G, Guitian J. Assessment of animal African trypanosomiasis (AAT) vulnerability in cattle-owning communities of sub-Saharan Africa. Parasites & vectors. 2016;9(1):53.
576. Grace D. Rational drug use. To better manage trypanosomosis and trypanocide resistance: ILRI (aka ILCA and ILRAD); 2003.
577. Moenga B, Muchemi G, Kang'ethe E, Kimenju J, Mutiga E, Matete G. The impact of climate change on the incidence of cattle diseases in a pastoral area of Kenya. Livest Res Rural Dev. 2013;25(4).
578. Kairu-Wanyoike SW, Kaitibie S, Taylor NM, Gitau GK, Heffernan C, Schnier C, et al. Exploring farmer preferences for contagious bovine pleuropneumonia vaccination: A case study of Narok District of Kenya. Preventive veterinary medicine. 2013;110(3-4):356-69.
579. Reid RS, Fernández-Giménez ME, Galvin KA. Dynamics and resilience of rangelands and pastoral peoples around the globe. Annual Review of Environment and Resources. 2014;39:217-42.

580. Bath GF, Penrith M-L, Leask R. A questionnaire survey on diseases and problems affecting sheep and goats in communal farming regions of the Eastern Cape province, South Africa. Journal of the South African Veterinary Association. 2016;87(1):1-10.
581. Benka V. Wildlife, Livestock, and Disease in Laikipia, Kenya: Pastoralist Observations. 2012.
582. AC08017547 A. Livestock keepers: guardians of biodiversity: Food and Agriculture Organization of the United Nations; 2009.
583. Abakar MF, Seli D, Lechthaler F, Schelling E, Tran N, Zinsstag J, et al. Vaccine hesitancy among mobile pastoralists in Chad: a qualitative study. International journal for equity in health. 2018;17(1):167.
584. Doss C. Data needs for gender analysis in agriculture. Gender in Agriculture: Springer; 2014. p. 55-68.
585. Bovard J. The continuing failure of foreign aid: Cato Institute Washington; 1986.
586. Onono JO, Wieland B, Rushton J. Factors influencing choice of veterinary service provider by pastoralist in Kenya. Tropical animal health and production. 2013;45(6):1439-45.
587. Fratkin E, Smith K. Women's changing economic roles with pastoral sedentarization: varying strategies in alternate Rendille communities. Human Ecology. 1995;23(4):433-54.
588. Grandin BE, editor Labour data collection. Pastoral Systems Research in Sub-Saharan Africa: proceedings of the IDRC/ILCA workshop held at ILCA, Addis Ababa, Ethiopia; 1983.
589. Nigussiel A, Hoag D, Alemu T. Women's workload and role in livestock production in pastoral and agro-pastoral communities of Ethiopia: The case of afar. African Journal of Agricultural Economics and Rural Development. 2014;2:138-46.
590. Burton ML, White DR. Sexual division of labor in agriculture. American Anthropologist. 1984;86(3):568-83.
591. Kirk L, Burton M. Meaning and context: A study of contextual shifts in meaning of Maasai personality descriptors. American Ethnologist. 1977;4(4):734-61.
592. Loos TK, Zeller M. Milk sales and dietary diversity among the Maasai. Agricultural economics. 2014;45(S1):77-90.
593. Hodgson DL. Rethinking pastoralism in Africa: James Currey Ltd; 2000.
594. Gifford-Gonzalez D. Gender and early pastoralists in East Africa. Gender in African prehistory. 1998:115-37.
595. Waithanji E, Mtimet N, Muindi P. Delivery of the Contagious Bovine Pleuropneumonia (CBPP) vaccine in northeastern Kenya. 2015.
596. Wangui EE. Links between gendered division of labour and land uses in Kajiado District, Kenya. 2003.
597. Hertkorn M-L, Roba H, Kaufmann B. Caring for livestock. Borana women's perceptions of their changing role in livestock management in southern Ethiopia. Nomadic Peoples. 2015;19(1):30-52.
598. Quinlan RJ, Rumas I, Naisikye G, Quinlan MB, Yoder J. Searching for Symbolic Value of Cattle: Tropical Livestock Units, Market Price, and Cultural Value of Maasai Livestock. Ethnobiology Letters. 2016;7(1):76-86.
599. Homewood K, Lewis J. Impact of drought on pastoral livestock in Baringo, Kenya 1983-85. Journal of applied Ecology. 1987:615-31.

600. Ayalew W, Rischkowsky B, King J, Bruns E. Crossbreds did not generate more net benefits than indigenous goats in Ethiopian smallholdings. Agricultural Systems. 2003;76(3):1137-56.
601. Leroy G, Baumung R, Boettcher P, Scherf B, Hoffmann I. Sustainability of crossbreeding in developing countries; definitely not like crossing a meadow…. animal. 2016;10(2):262-73.
602. Wurzinger M, Sölkner J, Iñiguez L. Important aspects and limitations in considering community-based breeding programs for low-input smallholder livestock systems. Small Ruminant Research. 2011;98(1):170-5.
603. Rege J, Marshall K, Notenbaert A, Ojango JM, Okeyo A. Pro-poor animal improvement and breeding—What can science do? Livestock science. 2011;136(1):15-28.
604. Kusiluka L, Kambarage D. Diseases of small ruminants: a handbook. Common Diseases of sheep and goats in Sub-Saharan Africa. 1996.
605. Malak A, Mpoke L, Banak J, Muriuki S, Skilton R, Odongo D, et al. Prevalence of livestock diseases and their impact on livelihoods in Central Equatoria State, southern Sudan. Preventive veterinary medicine. 2012;104(3-4):216-23.
606. Kenya Go. Laws of Kenya: Animal Diseases Act: Chapter 364. 2015.
607. Bedelian C, editor The impact of malignant catarrhal fever on Maasai pastoral communities. University of Edinburgh, UK; 2004: Citeseer.
608. Shiferaw T, Moses K, Manyahilishal K. Participatory appraisal of foot and mouth disease in the Afar pastoral area, northeast Ethiopia: implications for understanding disease ecology and control strategy. Tropical animal health and production. 2010;42(2):193-201.
609. Muhanguzi D, Mugenyi A, Bigirwa G, Kamusiime M, Kitibwa A, Akurut GG, et al. African animal trypanosomiasis as a constraint to livestock health and production in Karamoja region: a detailed qualitative and quantitative assessment. BMC veterinary research. 2017;13(1):355.
610. Molla B, Delil F. Mapping of major diseases and devising prevention and control regimen to common diseases in cattle and shoats in Dassenech district of South Omo Zone, South-Western Ethiopia. Tropical animal health and production. 2015;47(1):45-51.
611. Moenga B, Muchemi G, Kang'ethe E, Kimenju J, Mutiga E, Matete G. Impact of climate change on the incidences of small ruminant diseases in a pastoral area of Kenya. African Journal of Agricultural Research. 2016;11(27):2389-96.
612. Mazet JA, Clifford DL, Coppolillo PB, Deolalikar AB, Erickson JD, Kazwala RR. A "one health" approach to address emerging zoonoses: the HALI project in Tanzania. PLoS Medicine. 2009;6(12):e1000190.
613. Caudell MA, Quinlan MB, Quinlan RJ, Call DR. Medical pluralism and livestock health: ethnomedical and biomedical veterinary knowledge among east African agropastoralists. Journal of ethnobiology and ethnomedicine. 2017;13(1):7.
614. Cunningham AD, Andrews B. Western medicine as contested knowledge. New York: Manchester University Press; 1997.
615. Ole-Miaron J. The Maasai ethnodiagnostic skill of livestock diseases: a lead to traditional bioprospecting. Journal of Ethnopharmacology. 2003;84(1):79-83.
616. Bahemuka JM, Ekaya WN. Traditional Science and Knowledge in East Africa. History of Humanity–Vol VII–The Twentieth Century: Scientific and Cultural Development. 2008;7:110.

617. Omulo S, Thumbi SM, Njenga MK, Call DR. A review of 40 years of enteric antimicrobial resistance research in Eastern Africa: what can be done better? Antimicrobial resistance and infection control. 2015;4(1):1.
618. Kiara H. 2012.
619. Spinage CA. Cattle Plague A History. 1 ed. Boston: Springer US; 2003.
620. Government NC. 2014 [February 7th, 2014:[Available from: https://www.facebook.com/Narokcountygovernment/.
621. Government NC. 2015 [updated January 10th, 2015. Available from: https://www.facebook.com/Narokcountygovernment/.
622. Bellet C, Vergne T, Grosbois V, Holl D, Roger F, Goutard F. Evaluating the efficiency of participatory epidemiology to estimate the incidence and impacts of foot-and-mouth disease among livestock owners in Cambodia. Acta tropica. 2012;123(1):31-8.
623. Chenyambuga S, Waiswa C, Saimo M, Ngumi P, Gwakisa P. Knowledge and perceptions of traditional livestock keepers on tick-borne diseases and sero-prevalence of Theileria parva around Lake Victoria Basin. Livestock Research for Rural Development. 2010;22(7).
624. Majekodunmi AO, Dongkum C, Idehen C, Langs DT, Welburn SC. Participatory epidemiology of endemic diseases in West African cattle–Ethnoveterinary and bioveterinary knowledge in Fulani disease control. One Health. 2018.
625. Kioko J, Baker J, Shannon A, Kiffner C. Ethnoecological knowledge of ticks and treatment of tick-borne diseases among Maasai people in Northern Tanzania. Veterinary world. 2015;8(6):755.
626. Chenais E, Fischer K. Increasing the local relevance of epidemiological research: Situated knowledge of cattle disease among Basongora pastoralists in Uganda. Frontiers in Veterinary Science. 2018;5:119.
627. Kivaria FM, Kapaga AM, Mbassa GK, Mtui PF, Wani RJ. Epidemiological perspectives of ticks and tick-borne diseases in South Sudan: Cross-sectional survey results. Onderstepoort Journal of Veterinary Research. 2012;79(1):1-10.
628. Ohta I. Symptoms are Classified into Diagnostic Categories; Turkana's View of Livestock Diseases. 1984.
629. Catley A, Mariner J. Where there is no data: Participatory approaches to veterinary epidemiology in pastoral areas of the Horn of Africa. 2002.
630. Catley AP. Validation of participatory appraisal for use in animal health information systems in Africa. 2004.
631. Catley A, Okoth S, Osman J, Fison T, Njiru Z, Mwangi J, et al. Participatory diagnosis of a chronic wasting disease in cattle in southern Sudan. Preventive Veterinary Medicine. 2001;51(3):161-81.
632. Jacob MO, Farah KO, Ekaya WN. Indigenous knowledge: the basis of the Maasai Ethnoveterinary Diagnostic Skills. Journal of Human Ecology. 2004;16(1):43-8.
633. Laisser E, Chenyambuga S, Msalya G, Kipanyula M, Mdegela R, Karimuribo E, et al. Knowledge and perception on ticks, tick-borne diseases and indigenous cattle tolerance to East Coast fever in agro-pastoral communities of Lake Zone in Tanzania. Livestock Research for Rural Development. 2015;27:64.

634. Catley A. Use of participatory epidemiology to compare the clinical veterinary knowledge of pastoralists and veterinarians in East Africa. Tropical animal health and production. 2006;38(3):171-84.
635. Roderick S, Stevenson P, Mwendia C, Okech G. The use of trypanocides and antibiotics by Maasai pastoralists. Tropical animal health and production. 2000;32(6):361-74.
636. Muriuki F, Ogara W, Njeruh F, Mitema E. Tetracycline residue levels in cattle meat from Nairobi salughter house in. J Vet Sci. 2001;2(2):97-101.
637. Mugisha A, McLeod A, Percy R, Kyewalabye E. Strategies, effectiveness and rationale of vector-borne disease control in the pastoralist system of south-western Uganda. Tropical Animal Health and Production. 2005;37(6):479-89.
638. Suleiman A, Jackson E, Rushton J. Perceptions, circumstances and motivators affecting the implementation of contagious bovine pleuropneumonia control programmes in Nigerian Fulani pastoral herds. Preventive veterinary medicine. 2018;149:67-74.
639. Omadang L, Chamai M, Othieno E, Okwi A, Inangolet FO, Ejobi F, et al. Knowledge, attitudes and practices towards cystic echinococcosis in livestock among selected pastoral and agro-pastoral communities in Uganda. Tropical Animal Health and Production. 2017:1-7.
640. Flintan F. Changing Nature of Gender Roles in the Drylands of the Horn and East Africa: Implications for DRR Programming. REGLAP Summary Brief. 2011.
641. Nyokabi S, Birner R, Bett B, Isuyi L, Grace D, Güttler D, et al. Informal value chain actors' knowledge and perceptions about zoonotic diseases and biosecurity in Kenya and the importance for food safety and public health. Tropical animal health and production. 2018;50(3):509-18.
642. Coker R, Rushton J, Mounier-Jack S, Karimuribo E, Lutumba P, Kambarage D, et al. Towards a conceptual framework to support one-health research for policy on emerging zoonoses. The Lancet infectious diseases. 2011;11(4):326-31.
643. Schelling E, Grace D, Willingham III AL, Randolph T. Research approaches for improved pro-poor control of zoonoses. Food and Nutrition Bulletin. 2007;28(2_suppl2):S345-S56.
644. McDermott J, Grace D, Zinsstag J. Economics of brucellosis impact and control in low-income countries. Rev Sci Tech. 2013;32(1):249-61.
645. WHO. Roadmap for zoonotic tuberculosis. 2017.
646. Cleaveland S, Kambarage D, Kazwala R, Kunda J, French N. Participatory survey on zoonotic diseases affecting livestock keeping communities in Tanzania. Journal of Animal and Veterinary Advances. 2003.
647. Conlan JV, Sripa B, Attwood S, Newton PN. A review of parasitic zoonoses in a changing Southeast Asia. Veterinary parasitology. 2011;24. 182(1):22-40.
648. Jones B, McKeever D, Grace D, Pfeiffer D, Mutua F, Njuki J, et al. Zoonoses (Project 1): Wildlife/domestic livestock interactions. 2011.
649. Ndanu H, Onyango F, Massawe L, Matiko G. Participatory epidemiology: Dairy value chain assessment in eight villages in Tanzania. 2012.
650. Godfroid J, Al Dahouk S, Pappas G, Roth F, Matope G, Muma J, et al. A "One Health" surveillance and control of brucellosis in developing countries: moving away from improvisation. Comparative immunology, microbiology and infectious diseases. 2013;36(3):241-8.

651. Fèvre EM. Two stories on brucellosis in Kenya. 2013.
652. Wardrop NA, Thomas LF, Cook EA, de Glanville WA, Atkinson PM, Wamae CN, et al. The Sero-epidemiology of Coxiella burnetii in humans and cattle, western Kenya: evidence from a cross-sectional study. PLoS neglected tropical diseases. 2016;10(10):e0005032.
653. Kayombo G, Makingi G, Nonga H, Misinzo G, Kazwala R. Studies of brucellosis in lactating cows in Babati district, Tanzania. 2017.
654. Kaur M, Graham JP, Eisenberg JN. Livestock Ownership among Rural Households and Child Morbidity and Mortality: An Analysis of Demographic Health Survey Data from 30 Sub-Saharan African Countries (2005–2015). The American journal of tropical medicine and hygiene. 2017;96(3):741-8.
655. Joyce T, McGuigan K, Elmore-Meegan M, Conroy R. Prevalence of enteropathogens in stools of rural Maasai children under five years of age in the Maasailand region of the Kenyan Rift Valley. East African medical journal. 1996;73(1):59-62.
656. Ndeereh D, Muchemi G, Thaiyah A. Knowledge, attitudes and practices towards spotted fever group rickettsioses and Q fever in Laikipia and Maasai Mara, Kenya. Journal of public health in Africa. 2016;7(1).
657. Henderson RI, Hatfield J, Kutz S, Olemshumba S, Van Der Meer F, Manyama M, et al. 'We Can't Get Worms from Cow Dung': Reported Knowledge of Parasitism among Pastoralist Youth Attending Secondary School in the Ngorongoro Conservation Area, Tanzania. Journal of biosocial science. 2016;48(6):746-66.
658. John K, Kazwala R, Mfinanga GS. Knowledge of causes, clinical features and diagnosis of common zoonoses among medical practitioners in Tanzania. BMC infectious diseases. 2008;8(1):162.
659. Chipwaza B, Mugasa JP, Mayumana I, Amuri M, Makungu C, Gwakisa PS. Community knowledge and attitudes and health workers' practices regarding non-malaria febrile illnesses in eastern Tanzania. PLoS neglected tropical diseases. 2014;8(5):e2896.
660. Swai ES, Schoonman L, Daborn C. Knowledge and attitude towards zoonoses among animal health workers and livestock keepers in Arusha and Tanga, Tanzania. Tanzania Journal of Health Research. 2010;12(4):272-7.
661. Zhang HL, Mnzava KW, Mitchell ST, Melubo ML, Kibona TJ, Cleaveland S, et al. Mixed methods survey of zoonotic disease awareness and practice among animal and human healthcare providers in Moshi, Tanzania. PLoS neglected tropical diseases. 2016;10(3):e0004476.
662. Brah S, Daou M, Salissou L, Mahaman S, Alhousseini D, Iroungou A, et al. Fever of unknown origin in Africa: The causes are often determined! HEALTH SCIENCES AND DISEASES. 2015;16(2).
663. Omemo P, Ogola E, Omondi G, Wasonga J, Knobel D. Knowledge, attitude and practice towards zoonoses among public health workers in Nyanza province, Kenya. Journal of Public Health in Africa. 2012;3(2):22.
664. Njeru J, Melzer F, Wareth G, El-Adawy H, Henning K, Pletz MW, et al. Human brucellosis in febrile patients seeking treatment at remote hospitals, northeastern Kenya, 2014–2015. Emerging infectious diseases. 2016;22(12):2160.
665. Touré M, Petersen PT, Bathily SND, Sanogo D, Wang CW, Schiøler KL, et al. Molecular Evidence of Malaria and Zoonotic Diseases among Rapid Diagnostic Test–

Negative Febrile Patients in Low-Transmission Season, Mali. The American journal of tropical medicine and hygiene. 2017;96(2):335-7.
666. MUTUA PK. PASTORALISTS'PERCEPTIONS AND RISK OF HUMAN BRUCELLOSIS IN KAJIADO COUNTY, KENYA: UNIVERSITY OF NAIROBI; 2017.
667. Schelling E, Wyss K, Diguimbaye C, Béchir M, Taleb MO, Bonfoh B, et al. Towards integrated and adapted health services for nomadic pastoralists and their animals: A North–South partnership. Handbook of transdisciplinary research: Springer; 2008. p. 277-91.
668. Pertet AM, Kaseje D, Otieno-Odawa CF, Kirika L, Wanjala C, Ochieng J, et al. Under vaccination of children among Maasai nomadic pastoralists in Kenya: is the issue geographic mobility, social demographics or missed opportunities? BMC public health. 2018;18(1):1389.
669. Ahamad M. Ex-post Livestock Diseases, and Pastoralists' Averting Decisions in Tanzania. 2016.
670. Zinsstag J, Schelling E, Wyss K, Mahamat MB. Potential of cooperation between human and animal health to strengthen health systems. The Lancet. 2005;366(9503):2142-5.
671. Program IAH. FINAL TECHNICAL REPORT: DECISION SUPPORT FOR RISK MANAGEMENT STRATEGIES OF TICK-BORNE DISEASES WITHIN SUSTAINABLE PASTORAL SYSTEMS. 2003.
672. Owen E, Kitalyi A, Jayasuriya N, Smith T. Livestock and wealth creation: improving the husbandry of animals kept by resource-poor people in developing countries: Nottingham University Press; 2005.
673. Marsh TL, Yoder J, Deboch T, McElwain TF, Palmer GH. Livestock vaccinations translate into increased human capital and school attendance by girls. Science advances. 2016;2(12):e1601410.
674. Kairu-Wanyoike S, Kiara H, Heffernan C, Kaitibie S, Gitau G, McKeever D, et al. Control of contagious bovine pleuropneumonia: Knowledge, attitudes, perceptions and practices in Narok district of Kenya. Preventive veterinary medicine. 2014;115(3-4):143-56.
675. Barasa M, Catley A, Machuchu D, Laqua H, Puot E, Tap Kot D, et al. Foot-and-Mouth Disease Vaccination in South Sudan: Benefit-Cost Analysis and Livelihoods Impact. Transboundary and emerging diseases. 2008;55(8):339-51.
676. Catley A, Admassu B, Bekele G, Abebe D. Livestock mortality in pastoralist herds in Ethiopia and implications for drought response. Disasters. 2014;38(3):500-16.
677. Megersa B, Markemann A, Angassa A, Ogutu JO, Piepho H-P, Zaráte AV. Impacts of climate change and variability on cattle production in southern Ethiopia: Perceptions and empirical evidence. Agricultural systems. 2014;130:23-34.
678. Ayantunde AA, Turner MD, Kalilou A. Participatory analysis of vulnerability to drought in three agro-pastoral communities in the West African Sahel. Pastoralism. 2015;5(1):13.
679. Djoudi H, Locatelli B, Vaast C, Asher K, Brockhaus M, Sijapati BB. Beyond dichotomies: Gender and intersecting inequalities in climate change studies. Ambio. 2016;45(3):248-62.
680. Bett B, Jost C, Mariner J. Participatory investigation of important animal health problems amongst the Turkana pastoralists: Relative incidence, impact on livelihoods and suggested interventions. 2008.

681. de Haan N, Kimani T, Rushton J, Lubroth J. Why Is Small Ruminant Health Important—Peste des Petits Ruminants and Its Impact on Poverty and Economics? Peste des Petits Ruminants Virus: Springer; 2015. p. 195-226.
682. Ademosun A, editor Constraints and prospects for small ruminant research and development in Africa. Small Ruminant Research and Development in Africa Proceedings of the 2 nd Biennial Conference SRNET, AICC, Arusha, Tanzania; 1994.
683. Scagliarini A, Piovesana S, Turrini F, Savini F, Sithole F, McCrindle CM. Orf in South Africa: endemic but neglected. Onderstepoort Journal of Veterinary Research. 2012;79(1):1-8.
684. Pamo E, Boukila B, Tendonkeng F. Goat production research in Africa: a sign post review for research in the new millenium. International Journal of Biological and Chemical Sciences. 2007;1(1):76-89.
685. Akejo BS. Ruminants, resilience and poverty. 2017.
686. Otte M, Chilonda P. Cattle and small ruminant production systems in sub-Saharan Africa. A systematic review. 2002.
687. Al-Majali AM, Hussain NO, Amarin NM, Majok AA. Seroprevalence of, and risk factors for, peste des petits ruminants in sheep and goats in Northern Jordan. Preventive veterinary medicine. 2008;85(1-2):1-8.
688. Kihu S, Gachohi J, Gitao C, Bebora L, Njenga J, Wairire G, et al. Analysis of small ruminants' pastoral management practices as risk factors of Peste des petits ruminants (PPR) spread in Turkana District, Kenya. 2013.
689. Kihu SM, Gachohi JM, Ndungu EK, Gitao GC, Bebora LC, John NM, et al. Sero-epidemiology of Peste des petits ruminants virus infection in Turkana County, Kenya. BMC veterinary research. 2015;11(1):87.
690. Moore N, Messina J. A landscape and climate data logistic model of tsetse distribution in Kenya. PloS one. 2010;5(7):e11809.
691. Hordofa KS, Haile G. A review on epidemiological distribution, impacts and integrated control approach of tsetse fly. Journal of Parasitology and Vector Biology. 2017;9(9):122-31.
692. Ngonyoka A, Gwakisa PS, Estes AB, Salekwa LP, Nnko HJ, Hudson PJ, et al. Patterns of tsetse abundance and trypanosome infection rates among habitats of surveyed villages in Maasai steppe of northern Tanzania. Infectious diseases of poverty. 2017;6(1):126.
693. Butt B. Coping with uncertainty and variability: The influence of protected areas on pastoral herding strategies in East Africa. Human Ecology. 2011;39(3):289.
694. Nnko HJ, Ngonyoka A, Salekwa L, Estes AB, Hudson PJ, Gwakisa PS, et al. Seasonal variation of tsetse fly species abundance and prevalence of trypanosomes in the Maasai Steppe, Tanzania. Journal of Vector Ecology. 2017;42(1):24-33.
695. Catley A, Irungu P, Simiyu K, Dadye J, Mwakio W, Kiragu J, et al. Participatory investigations of bovine trypanosomiasis in Tana River District, Kenya. Medical and Veterinary Entomology. 2002;16(1):55-66.
696. Majekodunmi AO, Fajinmi A, Dongkum C, Picozzi K, MacLeod E, Thrusfield MV, et al. Social factors affecting seasonal variation in bovine trypanosomiasis on the Jos Plateau, Nigeria. Parasites & vectors. 2013;6(1):293.

697. Majekodunmi AO, Fajinmi A, Dongkum C, Picozzi K, Thrusfield MV, Welburn SC. A longitudinal survey of African animal trypanosomiasis in domestic cattle on the Jos Plateau, Nigeria: prevalence, distribution and risk factors. Parasites & vectors. 2013;6(1):239.
698. Kivaria FM, Kwiatek O, Kapaga AM, Swai ES, Libeau G, Moshy W, et al. The incursion, persistence and spread of peste des petits ruminants in Tanzania: Epidemiological patterns and predictions. Onderstepoort Journal of Veterinary Research. 2013;80(1):01-10.
699. Allepuz A, Stevenson M, Kivaria F, Berkvens D, Casal J, Picado A. Risk Factors for Foot-and-Mouth Disease in T anzania, 2001–2006. Transboundary and emerging diseases. 2015;62(2):127-36.
700. VanderWaal K, Gilbertson M, Okanga S, Allan BF, Craft ME. Seasonality and pathogen transmission in pastoral cattle contact networks. Royal Society open science. 2017;4(12):170808.
701. Bett B, Kiunga P, Gachohi J, Sindato C, Mbotha D, Robinson T, et al. Effects of climate change on the occurrence and distribution of livestock diseases. Preventive veterinary medicine. 2017;137:119-29.
702. Alsop Z. Malaria returns to Kenya's highlands as temperatures rise. The Lancet. 2007;370(9591):925-6.
703. Kanyari PW, Kagira JM, Mhoma JR. Prevalence of endoparasites in cattle within urban and peri-urban areas of Lake Victoria Basin, Kenya with special reference to zoonotic potential. Sci Parasitol. 2010;11:171-8.
704. Walker A, Bouattour A, Camicas J, Estrada-Peña A, Horak I, Latif A, et al. Ticks of domestic animals in Africa: a guide to identification of species. 2003. 2003.
705. KEESING F, OSTFELD RS, YOUNG TP, ALLAN BF. Cattle and rainfall affect tick abundance in central Kenya. Parasitology. 2018;145(3):345-54.
706. Mureithi SM, Opiyo FE, editors. Resource use planning under climate change: Experience from Turkana and Pokot pastoralists of Northwestern Kenya. Proceedings at 2nd International Conference on Climate, Sustainability and Development in Semi Arid Regions; 2010.
707. McCabe JT. Drought and recovery: livestock dynamics among the Ngisonyoka Turkana of Kenya. Human Ecology. 1987;15(4):371-89.
708. Mugabi KN, Mugisha A, Ocaido M. Socio-economic factors influencing the use of acaricides on livestock: a case study of the pastoralist communities of Nakasongola District, Central Uganda. Tropical animal health and production. 2010;42(1):131.
709. Mutavi F, Aarts N, Van Paassen A, Heitkönig I, Wieland B. Techne meets Metis: Knowledge and practices for tick control in Laikipia County, Kenya. NJAS-Wageningen Journal of Life Sciences. 2018;86:136-45.
710. Torr SJ, Prior A, Wilson P, Schofield S. Is there safety in numbers? The effect of cattle herding on biting risk from tsetse flies. Medical and veterinary entomology. 2007;21(4):301-11.
711. Motiang D, Webb EC. Herd mortality and cattle off-take rates among small-holder producers in the North West Province of South Africa. African Journal of Agricultural Research. 2016;11(11):930-4.
712. McPeak JG, Little PD. Applying the concept of resilience to pastoralist household data. Pastoralism. 2017;7(1):14.

713. Heffernan C. Consumer preferences and the uptake of animal healthcare by the poor: a case study from Kenya. Journal of international development. 2001;13(7):847-61.
714. Luseba D, Rwambo P. Review of the policy, regulatory and administrative framework for delivery of livestock health products and services in Eastern and Southern Africa. 2015.
715. Bardosh KL. Deadly flies, poor profits, and veterinary pharmaceuticals: sustaining the control of sleeping sickness in Uganda. Medical anthropology. 2016;35(4):338-52.
716. Leyland T, Lotira R, Abebe D, Bekele G, Catley A. Community-Based Animal Health Workers in the Horn of Africa An Evaluation for the Office of Foreign Disaster Assistance. Feinstein International Center, Tufts University Africa Regional Office, Addis Ababa and Vetwork UK, Great Holland. 2014.
717. Mockshell J, Ilukor J, Birner R. Providing animal health services to the poor in Northern Ghana: rethinking the role of community animal health workers? Tropical animal health and production. 2014;46(2):475-80.
718. Dzingirai V, Bett B, Bukachi S, Lawson E, Mangwanya L, Scoones I, et al. Zoonotic diseases: who gets sick, and why? Explorations from Africa. Critical Public Health. 2017;27(1):97-110.
719. Dzingirai V, Bukachi S, Leach M, Mangwanya L, Scoones I, Wilkinson A. Structural drivers of vulnerability to zoonotic disease in Africa. Phil Trans R Soc B. 2017;372(1725):20160169.
720. Godfroid J. Brucellosis in livestock and wildlife: zoonotic diseases without pandemic potential in need of innovative one health approaches. Archives of Public Health. 2017;75(1):34.
721. Donadeu M, Nwankpa N, Abela-Ridder B, Dungu B. Strategies to increase adoption of animal vaccines by smallholder farmers with focus on neglected diseases and marginalized populations. PLOS Neglected Tropical Diseases. 2019;13(2):e0006989.
722. MacGregor H, Waldman L. Views from many worlds: unsettling categories in interdisciplinary research on endemic zoonotic diseases. Phil Trans R Soc B. 2017;372(1725):20160170.
723. Wilkinson A, Leach M. Briefing: Ebola–myths, realities, and structural violence. African Affairs. 2015;114(454):136-48.
724. Millstone E, Odame H, Okumu O, Bardosh K. Stepping towards a policy response to Rift Valley fever. One Health: science, politics and zoonotic disease in Africa (ed K Bardosh). 2016:95-115.
725. Kgosikoma KR, Lekota PC, Kgosikoma OE. Agro-pastoralists' determinants of adaptation to climate change. International Journal of Climate Change Strategies and Management. 2018;10(3):488-500.
726. Little PD. Reflections on the future of pastoralism in the Horn of Africa. Pastoralism and development in Africa: dynamic change at the margins Routledge, New York, New York, USA. 2013:243-9.
727. Würthwein RP. Measuring the burden of disease and returns to education in rural West Africa: Duncker & Humblot; 2015.
728. Mboera LE, Mfinanga SG, Karimuribo ED, Rumisha SF, Sindato C. The changing landscape of public health in sub-Saharan Africa: Control and prevention of communicable diseases needs rethinking. Onderstepoort Journal of Veterinary Research. 2014;81(2):1-6.

729. Cooper RS, Osotimehin B, Kaufman JS, Forrester T. Disease burden in sub-Saharan Africa: what should we conclude in the absence of data? The Lancet. 1998;351(9097):208-10.
730. Jin J, Liang D, Shi L, Huang J. Trends in Between-Country Health Equity in Sub-Saharan Africa from 1990 to 2011: Improvement, Convergence and Reversal. International journal of environmental research and public health. 2016;13(6):620.
731. Glassman A, Ezeh A. Delivering on the data revolution in Sub-Saharan Africa. Washington, DC: Center for Global Development. 2014.
732. Coast E. Maasai Demography.(PhD). UCL, London. 2000.
733. Weibel D, Béchir M, Hattendorf J, Bonfoh B, Zinsstag J, Schelling E. Random demographic household surveys in highly mobile pastoral communities in Chad. Bulletin of the World Health Organization. 2011;89:385-9.
734. Queenan K, Mangesho P, Ole-Neselle M, Karimuribo E, Rweyemamu M, Kock R, et al. Using local language syndromic terminology in participatory epidemiology: lessons for One Health practitioners among the Maasai of Ngorongoro, Tanzania. Preventive veterinary medicine. 2017;139:42-9.
735. Ducrotoy M, Bertu W, Matope G, Cadmus S, Conde-Álvarez R, Gusi A, et al. Brucellosis in Sub-Saharan Africa: current challenges for management, diagnosis and control. Acta tropica. 2017;165:179-93.
736. Penakalapati G, Swarthout J, Delahoy MJ, McAliley L, Wodnik B, Levy K, et al. Exposure to animal feces and human health: A systematic review and proposed research priorities. Environmental Science & Technology. 2017.
737. O'Meara WP, Mangeni JN, Steketee R, Greenwood B. Changes in the burden of malaria in sub-Saharan Africa. The Lancet infectious diseases. 2010;10(8):545-55.
738. Defo BK. Demographic, epidemiological, and health transitions: are they relevant to population health patterns in Africa? Global health action. 2014;7(1):22443.
739. Etyang AO, Munge K, Bunyasi EW, Matata L, Ndila C, Kapesa S, et al. Burden of disease in adults admitted to hospital in a rural region of coastal Kenya: an analysis of data from linked clinical and demographic surveillance systems. The Lancet Global Health. 2014;2(4):e216-e24.
740. IEAG U. A World that Counts–Mobilising the Data Revolution for Sustainable Development. New York: United Nations. 2014.
741. Mbondji PE, Kebede D, Soumbey-Alley EW, Zielinski C, Kouvividila W, Lusamba-Dikassa P-S. Health information systems in Africa: descriptive analysis of data sources, information products and health statistics. Journal of the Royal Society of Medicine. 2014;107(1_suppl):34-45.
742. Aranda-Jan CB, Mohutsiwa-Dibe N, Loukanova S. Systematic review on what works, what does not work and why of implementation of mobile health (mHealth) projects in Africa. BMC public health. 2014;14(1):188.
743. Betjeman TJ, Soghoian SE, Foran MP. mHealth in sub-Saharan Africa. International journal of telemedicine and applications. 2013;2013:6.
744. Bloomfield GS, Vedanthan R, Vasudevan L, Kithei A, Were M, Velazquez EJ. Mobile health for non-communicable diseases in Sub-Saharan Africa: a systematic review of the literature and strategic framework for research. Globalization and health. 2014;10(1):49.

745. Gershgorn D. If AI is going to be the world's doctor, it needs better textbooks 2018 [Available from: https://qz.com/1367177/if-ai-is-going-to-be-the-worlds-doctor-it-needs-better-textbooks/.
746. Whittaker M. The role of social sciences in One Health: reciprocal benefits. One Health: The Theory and Practice of Integrated Health Approaches. 2015:60.
747. Coast E. Colonial preconceptions and contemporary demographic reality: Maasai of Kenya and Tanzania. 2001.
748. May A. Maasai migrations: Implications for HIV/AIDS and social change in Tanzania. Ann May. 2003.
749. Jacobson S. Maternal Health: Access to Care in Sauri, Kenya and Karamoja, Uganda. Comparative Analysis of Sauri, Kenya and Karamoja, Uganda by. 2016.
750. Mendes JR. MDG AccelerAtion coMpAct Accelerated Action plan for reducing Maternal Mortality. 2014.
751. Koini SM. Evaluation of Millennium Development Goals in Reduction of Maternal and Child Mortality in Narok County, Kenya. Journal of Education and Practice. 2017;8(9):31-42.
752. Colvin CJ, Smith HJ, Swartz A, Ahs JW, de Heer J, Opiyo N, et al. Understanding careseeking for child illness in sub-Saharan Africa: a systematic review and conceptual framework based on qualitative research of household recognition and response to child diarrhoea, pneumonia and malaria. Social Science & Medicine. 2013;86:66-78.
753. Greter H, Cowan N, Ngandolo BN, Kessely H, Alfaroukh IO, Utzinger J, et al. Treatment of human and livestock helminth infections in a mobile pastoralist setting at Lake Chad: attitudes to health and analysis of active pharmaceutical ingredients of locally available anthelminthic drugs. Acta tropica. 2017;175:91-9.
754. Zinsstag J, Tanner M. One health': the potential of closer cooperation between human and animal health in Africa. Ethiop J Health Dev. 2008;22:105-8.
755. De Garine-Wichatitsky M, Caron A, Kock R, Tschopp R, Munyeme M, Hofmeyr M, et al. A review of bovine tuberculosis at the wildlife–livestock–human interface in sub-Saharan Africa. Epidemiology & Infection. 2013;141(7):1342-56.
756. Othieno E, Okwi AL, Mupere E, Zeyhle E, Oba P, Chamai M, et al. Risk factors associated with cystic echinococcosis in humans in selected pastoral and agro-pastoral areas of Uganda. International Journal of One Health. 2017;3:1-6.
757. Solomon N, Zeyhle E, Carter J, Wachira J, Mengiste A, Romig T, et al. Cystic echinococcosis in Turkana, Kenya: the role of cross-sectional screening surveys in assessing the prevalence of human infection. The American journal of tropical medicine and hygiene. 2017;97(2):587-95.
758. Solomon N, Zeyhle E, Subramanian K, Fields P, Romig T, Kern P, et al. Cystic echinococcosis in Turkana, Kenya: 30 years of imaging in an endemic region. Acta tropica. 2018;178:182-9.
759. Odero J, Magambo J, Zeyhle E, Kutima H, Ndahi L, Njoroge F, et al. Prevalence of cystic echinococcosis and its economic significance in slaughtered livestock in kisumu east/west and isiolo districts of Kenya. 2015.
760. Addy F, Alakonya A, Wamae N, Magambo J, Mbae C, Mulinge E, et al. Prevalence and diversity of cystic echinococcosis in livestock in Maasailand, Kenya. Parasitology research. 2012;111(6):2289-94.

761. Oba P, Ejobi F, Omadang L, Chamai M, Okwi AL, Othieno E, et al. Prevalence and risk factors of Echinococcus granulosus infection in dogs in Moroto and Bukedea districts in Uganda. Tropical animal health and production. 2016;48(2):249-54.
762. Beyene H, Deressa W, Kumie A, Grace D. Determinants of diarrhoeal morbidity: The case of children under five years of age among agricultural and agro-pastoralist community of southern Ethiopia. Ethiopian Journal of Health Development. 2018;32(1).
763. Lindtjørn B, Alemu T, Bjorvatn B. Nutritional status and risk of infection among Ethiopian children. Journal of tropical pediatrics. 1993;39(2):76-82.
764. Barnes AN, Davaasuren A, Baasandagva U, Gray GC. A systematic review of zoonotic enteric parasitic diseases among nomadic and pastoral people. PloS one. 2017;12(11):e0188809.
765. Zolzaya B, Selenge T, Narangarav T, Gantsetseg D, Erdenechimeg D, Zinsstag J, et al. Representative seroprevalences of human and livestock brucellosis in two Mongolian provinces. EcoHealth. 2014;11(3):356-71.
766. McDermott JJ, Arimi S. Brucellosis in sub-Saharan Africa: epidemiology, control and impact. Veterinary microbiology. 2002;90(1-4):111-34.
767. Schelling E, Diguimbaye C, Daoud S, Nicolet J, Boerlin P, Tanner M, et al. Brucellosis and Q-fever seroprevalences of nomadic pastoralists and their livestock in Chad. Preventive veterinary medicine. 2003;61(4):279-93.
768. El Sherbini A, Kabbash I, Schelling E, El Shennawy S, Shalapy N, Elnaby GH, et al. Seroprevalences and local variation of human and livestock brucellosis in two villages in Gharbia Governorate, Egypt. Transactions of the Royal Society of Tropical Medicine and Hygiene. 2007;101(9):923-8.
769. Kubuafor D, Awumbila B, Akanmori B. Seroprevalence of brucellosis in cattle and humans in the Akwapim-South district of Ghana: public health implications. Acta Tropica. 2000;76(1):45-8.
770. Bonfoh B, Kasymbekov J, Dcorr S, Toktobaev N, Doherr MG, Schueth T, et al. Representative Seroprevalences of Brucellosis in Humans and Livestock in Kyrgyzstan. EcoHealth. 2012;9(2):132-8.
771. Dean AS, Crump L, Greter H, Schelling E, Zinsstag J. Global burden of human brucellosis: a systematic review of disease frequency. PLoS neglected tropical diseases. 2012;6(10):e1865.
772. Osoro EM, Munyua P, Omulo S, Ogola E, Ade F, Mbatha P, et al. Strong association between human and animal Brucella seropositivity in a linked study in Kenya, 2012–2013. The American journal of tropical medicine and hygiene. 2015;93(2):224-31.
773. Miller R, Nakavuma J, Ssajjakambwe P, Vudriko P, Musisi N, Kaneene J. The prevalence of brucellosis in cattle, goats and humans in rural Uganda: a comparative study. Transboundary and emerging diseases. 2016;63(6):e197-e210.
774. Okumu TA. Infectious Abortion and Associated Risk Factors in Dairy Cattle Farms in Nakuru District, Kenya: Thesis (PhD), Clinical Studies, University of Nairobi. Available at: http://erepository. uonbi. ac. ke/bitstream/handle/11295/75174/Okumu_Infectious abortion and associated risk factors in dairy cattle farms in Nakuru district, Kenya. pdf; 2014.
775. Gele AA. Socio-cultural Attributes in the Management and Control of Tuberculosis among Somali Pastoralist Communities in Somali Regional State of Ethiopia 2008.

776. Lô A, Tall-Dia A, Bonfoh B, Schelling E. Tuberculosis among transhumant pastoralist and settled communities of south-eastern Mauritania. Global health action. 2016;9(1):30334.
777. Fratkin E, Nathan MA, Roth EA. Is settling good for pastoralists? The effects of pastoral sedentarization on children's nutrition, growth, and health among Rendille and Ariaal of Marsabit District, northern Kenya. International Livestock Research Institute, Nairobi, Kenya. 2006.
778. Fratkin EM, Roth EA, Nathan MA. When nomads settle: the effects of commoditization, nutritional change, and formal education on Ariaal and Rendille pastoralists. Current anthropology. 1999;40(5):729-35.
779. Nathan MA, Fratkin EM, Roth EA. Sedentism and child health among Rendille pastoralists of northern Kenya. Social science & medicine. 1996;43(4):503-15.
780. Njuguna J, Muruka C. Open Defecation in Newly Created Kenyan Counties: A Situational Analysis. Journal of Health Care for the Poor and Underserved. 2017;28(1):71-8.
781. Keats EC, Ngugi A, Macharia W, Akseer N, Khaemba EN, Bhatti Z, et al. Progress and priorities for reproductive, maternal, newborn, and child health in Kenya: a Countdown to 2015 country case study. The Lancet Global Health. 2017;5(8):e782-e95.
782. Keats EC, Macharia W, Singh NS, Akseer N, Ravishankar N, Ngugi AK, et al. Accelerating Kenya's progress to 2030: understanding the determinants of under-five mortality from 1990 to 2015. BMJ global health. 2018;3(3):e000655.
783. Little P. Unofficial trade when states are weak: The case of cross-border livestock trade in the Horn of Africa. African Pastoralism: Past, Present and Future—The Emergence, History and Contemporary Political Ecology of African Pastoralism. 2013:387-410.
784. Irungu P, Bett B, Mbogoh S, Nyamwaro S, Murilla G, Randolph T. Evidence of improper usage of veterinary drugs in cattle in Maasailand, Kenya. Bulletin of animal health and production in Africa. 2007;55(4):210-25.
785. James PA, Oparil S, Carter BL, Cushman WC, Dennison-Himmelfarb C, Handler J, et al. 2014 evidence-based guideline for the management of high blood pressure in adults: report from the panel members appointed to the Eighth Joint National Committee (JNC 8). Jama. 2014;311(5):507-20.
786. Lemma F, Shetty P. Seasonal variations in the relationship between mid-upper arm circumference and maximum voluntary contraction among ethiopian farmers. European journal of clinical nutrition. 2009;63(4):513.
787. Ferro-Luzzi A, James W. Adult malnutrition: simple assessment techniques for use in emergencies. British journal of nutrition. 1996;75(1):3-10.
788. Powell-Tuck J, Hennessy EM. A comparison of mid upper arm circumference, body mass index and weight loss as indices of undernutrition in acutely hospitalized patients. Clinical Nutrition. 2003;22(3):307-12.
789. Woodruff BA, Duffield A. Assessment of nutritional status in emergency-affected populations. Geneva: United Nations/Sub-Committee on Nutrition. 2000.
790. Tang AM, Chung M, Dong K, Terrin N, Edmonds A, Assefa N, et al. Determining a global mid-upper arm circumference cutoff to assess malnutrition in pregnant women. Food and Nutrition Technical Assistance. 2016.

791. Tang AM, Dong K, Deitchler M, Chung M, Maalouf-Manasseh Z, Tumilowicz A, et al. Use of cutoffs for mid-upper arm circumference (MUAC) as an indicator or predictor of nutritional and health-related outcomes in adolescents and adults: A systematic review. 2013.
792. Provan D. Oxford handbook of clinical and laboratory investigation: Oxford university press; 2018.
793. Omuse G, Maina D, Mwangi J, Wambua C, Radia K, Kanyua A, et al. Complete blood count reference intervals from a healthy adult urban population in Kenya. PloS one. 2018;13(6):e0198444.
794. Chobanian A, Bakris G, Black H, Cushman W, Green L, Izzo J, et al. Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure. National Heart, Lung, and Blood Institute; National High Blood Pressure Education Program Coordinating Committee. The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure: the JNC 7 report. Hypertension. 2003;42(6):1206-52.
795. Zhou B, Bentham J, Di Cesare M, Bixby H, Danaei G, Cowan MJ, et al. Worldwide trends in blood pressure from 1975 to 2015: a pooled analysis of 1479 population-based measurement studies with 19· 1 million participants. The Lancet. 2017;389(10064):37-55.
796. Etyang AO, Smeeth L, Cruickshank JK, Scott JAG. The malaria-high blood pressure hypothesis. Circulation research. 2016;119(1):36-40.
797. Rasmussen JB, Mwaniki DL, Kaduka LU, Boit MK, Borch-Johnsen K, Friis H, et al. Hemoglobin levels and blood pressure are associated in rural black africans. American Journal of Human Biology. 2016;28(1):145-8.
798. Njelekela M, Negishi H, Nara Y, Tomohiro M, Kuga S, Noguchi T, et al. Cardiovascular risk factors in Tanzania: a revisit. Acta tropica. 2001;79(3):231-9.
799. Ngoye A, Petrucka P, Buza J. Differences in hypertension risk factors between rural maasai in ngorongoro and urban maasai in arusha municipal: A descriptive study. International Journal of Life Sciences. 2014;1(1):17-31.
800. Lennox J, Petrucka P, Bassendowski S. Eating practices during pregnancy: perceptions of select Maasai women in Northern Tanzania. Global health research and policy. 2017;2(1):9.
801. Lennox JL. Understanding Pregnant Maasai Women's Nutrition Patterns and Beliefs Regarding Pregnancy Outcomes: University of Saskatchewan; 2016.
802. Anderson DM. The beginning of time? Evidence for catastrophic drought in Baringo in the early nineteenth century. Journal of Eastern African Studies. 2016;10(1):45-66.
803. Huho JM, Ngaira JK, Ogindo HO. Living with drought: the case of the Maasai pastoralists of northern Kenya. Educational Research. 2011;2(1):779-89.
804. Njoka JT, Yanda P, Maganga F, Liwenga E, Kateka A, Henku A, et al. Kenya: Country situation assessment. PRISE working paper. http://prise. odi. org/wp-con tent/uploads/2016/01/Low-Res_Kenya-CSA. pdf; 2016.
805. Galvin KA, Beeton TA, Boone RB, BurnSilver SB. Nutritional status of Maasai pastoralists under change. Human ecology. 2015;43(3):411-24.
806. Homewood KM. Development and the ecology of Maasai pastoralist food and nutrition. Ecology of food and nutrition. 1992;29(1):61-80.

807. Odhiambo F, Omoro N. Reconsidering Education for All at a time of Change: Influence of Economic Factors on access to Secondary Education in Narok County, Kenya. International Journal for Innovation Education and Research. 2015;3(12).
808. Martin H, Petrucka P, Buza J. Determination of Vitamins A, C and D Status Using Serum Markers and a 24-Hour Dietary Recall among Maasai Women of Reproductive Age. Open Access Library Journal. 2014;1(08):1.
809. Mwabu G, Ainsworth M, Nyamete A. Quality of medical care and choice of medical treatment in Kenya: an empirical analysis. Journal of Human Resources. 1993:838-62.
810. Prosser T. Utilization of health and medical services: Factors influencing health care seeking behaviour and unmet health needs in rural areas of Kenya. 2007.
811. Müller O, Traoré C, Becher H, Kouyaté B. Malaria morbidity, treatment-seeking behaviour, and mortality in a cohort of young children in rural Burkina Faso. Tropical Medicine & International Health. 2003;8(4):290-6.
812. Noordam AC, Carvajal-Velez L, Sharkey AB, Young M, Cals JW. Care seeking behaviour for children with suspected pneumonia in countries in sub-Saharan Africa with high pneumonia mortality. PLoS One. 2015;10(2):e0117919.
813. Alvin M, Mogere D. Does the ownership and use of Mosquito treated nets by household members depend on the level of Education of the head of household? case study of Western Kenya. Value in Health. 2015;18(3):A92.
814. Ruyange MM, Condo J, Karema C, Binagwaho A, Rukundo A, Muyirukazi Y. Factors associated with the non-use of insecticide-treated nets in Rwandan children. Malaria journal. 2016;15(1):355.
815. Alaii JA, Hawley WA, Kolczak MS, Ter Kuile FO, Gimnig JE, Vulule JM, et al. Factors affecting use of permethrin-treated bed nets during a randomized controlled trial in western Kenya. The American journal of tropical medicine and hygiene. 2003;68(4_suppl):137-41.
816. Singh M, Brown G, Rogerson SJ. Ownership and use of insecticide-treated nets during pregnancy in sub-Saharan Africa: a review. Malaria journal U6 - ctx_ver=Z3988-2004&ctx_enc=info%3Aofi%2Fenc%3AUTF-8&rfr_id=info%3Asid%2Fsummonserialssolutionscom&rft_val_fmt=info%3Aofi%2Ffmt%3Akev%3Amtx%3Ajournal&rftgenre=article&rftatitle=Ownership+and+use+of+insecticide-treated+nets+during+pregnancy+in+sub-Saharan+Africa%3A+a+review&rftjtitle=Malaria+Journal&rftau=Megha+Singh&rftau=Graham+Brown&rftau=Stephen+J+Rogerson&rftdate=2013-01-01&rftpub=BioMed+Central&rfteissn=1475-2875&rftvolume=12&rft_id=info:doi/101186%2F1475-2875-12-268&rftexternalDocID=3041408171&paramdict=en-US U7 - Journal Article. 2013;12:268.
817. Sangaré LR, Weiss NS, Brentlinger PE, Richardson BA, Staedke SG, Kiwuwa MS, et al. Determinants of use of insecticide treated nets for the prevention of malaria in pregnancy: Jinja, Uganda. PLoS One. 2012;7(6):e39712.
818. Ezire O, Adebayo SB, Idogho O, Bamgboye EA, Nwokolo E. Determinants of use of insecticide-treated nets among pregnant women in Nigeria. International journal of women's health. 2015;7:655.

819. Nyamai R, Knight V, Ochanda D. Effective utilization of insecticide treated nets and hospitalization of children under five years at matete health centre in western kenya. International Journal of Development Research. 2018;8(03).
820. Ernst KC, Hayden MH, Olsen H, Cavanaugh JL, Ruberto I, Agawo M, et al. Comparing ownership and use of bed nets at two sites with differential malaria transmission in western Kenya. Malaria journal. 2016;15(1):217.
821. Carvajal-Vélez L, Amouzou A, Perin J, Maïga A, Tarekegn H, Akinyemi A, et al. Diarrhea management in children under five in sub-Saharan Africa: does the source of care matter? A Countdown analysis. BMC public health. 2016;16(1):830.
822. AMREF. Effectiveness of expanded delivery mechanisms/ channels and empowerment of caregivers in improving access of ORS and Zinc in Narok County, Kenya. 2015.
823. Carter E, Bryce J, Perin J, Newby H. Harmful practices in the management of childhood diarrhea in low-and middle-income countries: a systematic review. BMC public health. 2015;15(1):788.
824. Kimang'a AN, Revathi G, Kariuki S, Sayed S, Devani S. Helicobacter pylori: prevalence and antibiotic susceptibility among Kenyans. South African Medical Journal. 2010;100(1).
825. Muriuki S, McDermott J, Arimi S, Mugambi J, Wamola I. Criteria for better detection of brucellosis in the Narok District of Kenya. East African medical journal. 1997;74(5):317-20.
826. Maichomo M, McDermott J, Arimi S, Gathura P. Assessment of the Rose-Bengal plate test for the diagnosis of human brucellosis in health facilities in Narok district, Kenya. East African medical journal. 1998;75(4):219-22.
827. Thitu A, Augustine MKA. Factors Influencing Latrine Coverage Among The Maasai Of Ildamat Location Kajiado District. Unpublished Msc thesis, Great Lakes University Of Kisumu, Kenya. 2010.
828. Mshida HA, Kassim N, Kimanya ME, Mpolya E. Influence of Water, Sanitation, and Hygiene Practices on Common Infections among Under-Five Children in Longido and Monduli Districts of Arusha, Tanzania. Journal of environmental and public health. 2017;2017.
829. Nyariki DM, W. Mwang'ombe A, Thompson D. Land-use change and livestock production challenges in an integrated system: the Masai-Mara ecosystem, Kenya. Journal of Human Ecology. 2009;26(3):163-73.
830. Catley A, Admassu B. Using participatory epidemiology to assess the impact of livestock diseases. Community-based Animal Health and Participatory Epidemiology (CAPE) Unit. 2003.
831. Ayal DY, Radeny M, Desta S, Gebru G. Climate variability, perceptions of pastoralists and their adaptation strategies: Implications for livestock system and diseases in Borana zone. International Journal of Climate Change Strategies and Management. 2018;10(4):596-615.
832. Swallow B. Potential for poverty reduction strategies to address community priorities: case study of Kenya. World Development. 2005;33(2):301-21.

833. Essendi H, Madise N, Matthews Z. Perceptions of development by residents of a rural community in Kenya: A capability issue. Journal of African Studies and Development. 2014;6(4):67.
834. Tompkins AM, Di Giuseppe F. Potential predictability of malaria in Africa using ECMWF monthly and seasonal climate forecasts. Journal of Applied Meteorology and Climatology. 2015;54(3):521-40.
835. Mabaso M, Ndlovu N. Critical review of research literature on climate-driven malaria epidemics in sub-Saharan Africa. Public Health. 2012;126(11):909-19.
836. Yusuf S, Piedimonte G, Auais A, Demmler G, Krishnan S, Van Caeseele P, et al. The relationship of meteorological conditions to the epidemic activity of respiratory syncytial virus. Epidemiology & Infection. 2007;135(7):1077-90.
837. Bailis R, Pennise D, Ezzati M, Kammen DM, Kituyi E. Impacts of greenhouse gas and particulate emissions from woodfuel production and end-use in sub-Saharan Africa. Berkeley, CA: Renewable and Appropriate Energy Laboratory. 2004.
838. Alonso WJ, Laranjeira BJ, Pereira SA, Florencio CM, Moreno EC, Miller MA, et al. Comparative dynamics, morbidity and mortality burden of pediatric viral respiratory infections in an equatorial city. The Pediatric infectious disease journal. 2012;31(1):e9.
839. Ye Y, Zulu E, Mutisya M, Orindi B, Emina J, Kyobutungi C. Seasonal pattern of pneumonia mortality among under-five children in Nairobi's informal settlements. The American journal of tropical medicine and hygiene. 2009;81(5):770-5.
840. Dibaba AB, Daborn C, Cadmus S, Michel A. The Current Status of Bovine Tuberculosis in Africa. Tuberculosis in Animals: An African Perspective: Springer; 2019. p. 15-30.
841. Mugambi J, Omwenga S, Wesonga H, Mbatha P, Gathogo S, Chota A, et al. Bovine Tuberculosis in East Africa. African Crop Science Journal. 2016;24(1):53-61.
842. Anchang KY, Avery L, Pertiwiningrum A. A commentary on occupational infectious diseases due to agricultural practices in sub-Saharan Africa. Biomass and bioenergy. 2014;70:99-111.
843. Headey D, Nguyen P, Kim S, Rawat R, Ruel M, Menon P. Is Exposure to Animal Feces Harmful to Child Nutrition and Health Outcomes? A Multicountry Observational Analysis. The American journal of tropical medicine and hygiene. 2017;96(4):961-9.
844. Barnes AN, Anderson JD, Mumma J, Mahmud ZH, Cumming O. The association between domestic animal presence and ownership and household drinking water contamination among peri-urban communities of Kisumu, Kenya. PloS one. 2018;13(6):e0197587.
845. Zambrano LD, Levy K, Menezes NP, Freeman MC. Human diarrhea infections associated with domestic animal husbandry: a systematic review and meta-analysis. Transactions of the Royal Society of Tropical Medicine and Hygiene. 2014;108(6):313-25.
846. Conan A, O'Reilly CE, Ogola E, Ochieng JB, Blackstock AJ, Omore R, et al. Animal-related factors associated with moderate-to-severe diarrhea in children younger than five years in western Kenya: A matched case-control study. PLoS neglected tropical diseases. 2017;11(8):e0005795.
847. Stewart CP, Kariger P, Fernald L, Pickering AJ, Arnold CD, Arnold BF, et al. Effects of water quality, sanitation, handwashing, and nutritional interventions on child development

in rural Kenya (WASH Benefits Kenya): a cluster-randomised controlled trial. The lancet child & adolescent health. 2018;2(4):269-80.
848. Cumming O, Curtis V. Implications of WASH Benefits trials for water and sanitation. The Lancet Global Health. 2018;6(6):e613-e4.
849. Organization WH. The control of neglected zoonotic diseases: community based interventions for NZDs prevention and control: report of the third conference organized with ICONZ, DFID-RiU, SOS, EU, TDR and FAO with the participation of ILRI and OIE: 23-24 November 2010, WHO Heaquarters, Geneva, Switzerland. 2011.
850. Arocha JF, Patel VL. Making Sense of Health Problems: Folk Cognition and Healthcare Decisions. Cognitive Informatics in Health and Biomedicine: Springer; 2017. p. 45-64.
851. Kotsila P. Health dispossessions and the moralization of disease: the case of diarrhea in the Mekong Delta, Vietnam. Ecology. 2017;24:1-124.
852. Patel VL, Eisemon TO, Arocha J. Causal reasoning and the treatment of diarrhoeal disease by mothers in Kenya. Social Science & Medicine. 1988;27(11):1277-86.
853. Mcpeak JG, Doss CR, Barrett CB, Kristjanson P. Do community members share development priorities? Results of a ranking exercise in East African rangelands. The Journal of Development Studies. 2009;45(10):1663-83.
854. Wirth M, Sacks E, Delamonica E, Storeygard A, Minujin A, Balk D. "Delivering" on the MDGs?: equity and maternal health in Ghana, Ethiopia and Kenya. East African journal of public health. 2008;5(3):133.
855. Rutherford ME, Mulholland K, Hill PC. How access to health care relates to under-five mortality in sub-Saharan Africa: systematic review. Tropical medicine & international health. 2010;15(5):508-19.
856. Klous G, Huss A, Heederik DJ, Coutinho RA. Human–livestock contacts and their relationship to transmission of zoonotic pathogens, a systematic review of literature. One Health. 2016;2:65-76.
857. Egeru A, Nandozi, C., Kyobutungi, A, and Tabuti, J. Dimensions of Vulnerability to Climate Change and Variability in Pastoral Production Systems in East Africa. In: Yanda PaMooC, editor. Pastoralism and Climate Change2016.
858. Willy DK, Chiuri W. New Common Ground in Pastoral and Settled Agricultural Communities in Kenya: Renegotiated Institutions and the Gender Implications. The European Journal of Development Research. 2010;22(5):733-50.
859. Hodgson DL. Engendered Encounters: Men of the Church and the "Church of Women" in Maasailand, Tanzania, 1950–1993. Comparative studies in society and history. 1999;41(04):758-83.
860. Liu T, Bruins R, Heberling M. Factors influencing farmers' adoption of best management practices: A review and synthesis. Sustainability. 2018;10(2):432.
861. Allan KJ, Biggs HM, Halliday JE, Kazwala RR, Maro VP, Cleaveland S, et al. Epidemiology of leptospirosis in Africa: a systematic review of a neglected zoonosis and a paradigm for 'One Health'in Africa. PLoS neglected tropical diseases. 2015;9(9):e0003899.
862. Galaz V, Leach M, Scoones I, Stein C. The political economy of One Health research and policy. 2015.
863. Kingsley P, Taylor E. One Health: competing perspectives in an emerging field. Parasitology. 2017;144(1):7-14.

Appendices

Appendix A Sociodemographic and Health Questionnaire

Adults and older children

General Information

Date of interview: |__|__| day |__|__| month **2008**

1) Identity Code for Individual seen

_____

2) Ethnicity?

1. Maasai |__|
2. Other |__|
3. Other _____

3) Sex?

1. Female |__| 2. Male |__|

4) Age?

Years |__||__|

5) Type of house

Traditional |__|
Other (describe) _____

6) Education

None |__|
Primary |__|
Secondary |__|
Post-secondary |__|

Total years |__||__|
Reason for lack of schooling/school termination _____

7) Matrimonial status?

1. single |__|
2. married/ monogamous |__|
3. married/polygamous |__| → *if Yes*: Number|___|___|
   if Yes and female: Position|___|___|
4. separated/divorced |__|
5. widow/er |__|

If married, age at marriage Years |___|___|

8) Number of births?

Number|___|___|

9) Number of living children?

Number|___|___|

10) Number of children under 5?

Number|___|___|

11) Age and sex of children and Education Attained

First born

Age Years |___|___| Sex Female|___| Male |___| In school currently Yes No

Education: Primary|___| Secondary|___| Post-Sec|___| Total years |___|___|

If did not attend/complete school, reason for termination

_____

Second (and more as necessary)

Age Years |___|___| Sex Female|___| Male |___| In school currently Yes|___| No|___|

Education: Primary|___| Secondary|___| Post-Sec|___| Total years|___|___|

If did not attend/complete school, reason for termination

_____

12) Livelihoods

Male head of household

1. Pastoralist |__|
2. Business | |
3. Other (describe) _____
4. Other (describe) _____

If not pastoral, why?

_____

Wives

First wife (household revenue)

1. From husband | |
2. Beading/Crafts |__|
3. Livestock (describe) _____
4. Business (describe) _____
5. Other (describe) _____

Second wife (and more as necessary)

1. From husband | |
2. Beading/Crafts | |
3. Livestock (describe) _____
4. Business (describe) _____
5. Other (describe) _____

General Health (to be filled in by the nurse)

Date of interview: |__|__| day |__|__| month **2008**

1) General state of health

1. Good |__|
2. Poor |__|
3. Very poor |__|

2) Palpation LIVER

1. Normal |__|
2. Swollen |__|

3) Palpation LYMPH NODES

1. Neck |___|1: swollen; 0: normal
2. Groin |___|1: swollen; 0: normal
3. General |___|1: swollen; 0: normal

4) Auscultation HEART

Rate: |_____|bpm

5) Height/MUAC

Height |__¦__|__| cm MUAC |__¦__| cm

6) Blood pressure / Temperature

Blood pressure |__¦__| mmHg Temperature |__¦__| C

7) Have you been sick in the last 14 days?

0. No |__| 1. Yes |__|

8) *If Yes*, what were the symptoms or disease or what do you suspect from the symptoms?

_____

_____

_____

Health care and utilization of health services (to be filled in by the nurse)

9) Have you received treatment for this illness?

0. No |__| 1. Yes |__|

10) If *Yes*, from whom?

1) Self-medicated |____|
2) Health facility |____|
3) Traditional healer |____|

11) When you are sick, do you use a medical facility?

0. No |__| 1. Yes |__|

12) If no, why?

1. No time |__|
2. Expensive |__|
3. Too far |__|
4. Poor welcome |__|
5. Poor quality of care |__|
6. Not our tradition |__|
7._____ |__|
8._____ |__|
9. _____ |__|

Prenatal care and maternal vaccination coverage (to be filled in by the nurse)

1) Total number pregnancies?

Number |___|___| *(compare with responses 8-9)*

2) Number of miscarriages?

Number |___|___|

3) Date of birth of last infant?

Day |___|___| month |___|___| year |___|___| |___|___|

4) Do you have a vaccination card for your children?

0. No |__| 1. Yes |__|

5) Number of prenatal consultations during your last pregnancy?

Number |___|___|

6) Where was your last child born?

1. Hospital |__|
2. Home |__|
3. Other:_____

7) Who cut the umbilical cord?

1. Traditional birth attendant|__|
2. Mid-wife |__|
3. Parent |__|
4. Neighbour |__|
5. Other:_____

Risk factors for exposure to zoonoses, nutrition and malaria

1) Are you familiar with chloroquine?

0. No |__| 1. Yes |__|

2 *If Yes*: Do you take it when you have malaria?

0. No |__| 1. Yes |__|

3) Do you use a mosquito net for sleeping?

0. No |__| 1. Yes |__|

4 If *Yes*: When do you use it?

1. All year |__|
2. During the rainy season |__|
3. When it's hot |__|
4. Other:_____

5) Who sleeps under the mosquito net?

1. The whole family |__|
2. Only the children |__|
3. Only the parents |__|
4. Only the father |__|
5. Others:_____

6) If *No*: Why not?

_____

7) Have you hear of impregnated mosquito nets?

0. No |__| 1. Yes |__| □

8) If Yes: From where?

_____

9) What are your sources of drinking water?

1. _____
2. _____

10) Do you treat any of your water?

Yes |__| No|__|

If yes, how? _____

11) What did you eat yesterday and how much?

1. Milk |___| 1=Yes 0=No
2. Grains |___| 1=Yes 0=No
3. Fresh vegetables |___| 1=Yes 0=No → only in a stew/sauce |__|
4. Dried vegetables |___| 1=Yes 0=No → only in a stew/sauce |__|
5. Meat |___| 1=Yes 0=No
6. Liver |___| 1=Yes 0=No

12) Do you consume liver?

0. No |__| 1. Yes |__|

13) Do you consume fresh or soured milk?

0. No |__| 1. Yes |__|

14) Do you intervene to remove the offspring when an animal in labour is obstructed?

0. No |__| 1. Yes |__|

15) In the case of an animal retaining the placenta or having an abortion, do you have contact with either?

0. No |__| 1. Yes |__|

16) When an animal is killed, (for a ceremony, circumcision, marriage etc), do you assist in the slaughter and butchering?

0. No |__| 1. Yes |__|

17) If *Yes*:

Species	**1. Slaughtering**	**2. Butchering**
1. Cows →	|__|	|__|
2. Goats →	|__|	|__|
3. Sheep →	|__|	|__|

18) Are there any parts of the carcass that you consume raw?

0. No |__| 1. Yes |__|

19) If *Yes*: Which parts?

``

stomach |__|
dried meat |__|
liver |__|

Appendix B Livestock duties Script, SWLS, and Wellbeing

Livestock Duties Script

Do you have a herder?

Do you herd?

Do you identify sick animals?

Do you treat livestock?

Do you buy livestock?

Do you sell livestock?

Do you milk livestock?

Do you slaughter and butcher livestock?

Do you assist in birthing livestock?

Do you own any of your own livestock?[r]

Satisfaction with Life Scale[309]

Below are five statements that you may agree or disagree with. Using the 1 - 7 scale below, indicate your agreement with each item by placing the appropriate number on the line preceding that item. Please be open and honest in your responding.

- 7 - Strongly agree
- 6 - Agree
- 5 - Slightly agree
- 4 - Neither agree nor disagree
- 3 - Slightly disagree
- 2 - Disagree
- 1 - Strongly disagree

[r] Asked of women only.

____ In most ways my life is close to my ideal.

____ The conditions of my life are excellent.

____ I am satisfied with my life.

____ So far I have gotten the important things I want in life.

____ If I could live my life over, I would change almost nothing."

Specific Contributors and Detractors to to and from Current and Future Wellbeing

Please consider your current life circumstances as fully as possible. Taking into consideration all the aspects of your current life, what one factor contributes most positively to your current wellbeing?

Now, consider what one factor detracts most significantly from your current wellbeing?

Please consider your anticipated wellbeing in the future. What one factor do you think will contribute most positively to your future wellbeing?

What one factor do you think could detract from your future wellbeing?

Contribution of Livestock to Wellbeing

Do livestock contribute positively to your wellbeing? If yes, how?

Do livestock contribute negatively to your wellbeing? If yes, how?

Appendix C Livestock Disease Prioritization and Understanding

Rationales for Disease Ranking

	Livestock Disease in Order of Self-Reported Community Impact										
Rationale for Ranking	CB/CPP	"ECF"	Tryp.	"Ent."	FMD	Heart-water	Red-water	S&G Pox	Anthr.	"Olodua"	**Ranked Frequency of Rationale**
Causes fatalities	30 (31.6%)	23 (23.0%)	3 (3.2%)	19 (29.2%)	7 (13.7%)	7 (21.9%)	2 (7.7%)	4 (15.4%)	1 (5.6%)	4 (30.8%)	1 (100)
No answer/ record missing	24 (24%)	12 (12.6%)	19 (20%)	10 (15.4%)	2 (3.9%)	5 (15.6%)	4 (15.4%)	10 (38.5%)	1 (5.6%)	1 (7.7%)	2 (88)
No/Unreliable Treatment	15 (15.8%)	13 (13%)	0 (0.0%)	14 (21.5%)	4 (7.8%)	12 (37.5%)	4 (15.4%)	3 (11.5%)	1 (5.6%)	1 (7.7%)	3 (67)
Rapid onset of mortality	19 (20.0%)	8 (8.0%)	0 (0.0%)	8 (12.3%)	0 (0.0%)	0 (0.0%)	16 (61.5%)	3 (11.5%)	4 (22.2%)	2 (15.4%)	4 (60)
Common/ Endemic	1 (1.1%)	5 (5.0%)	35 (36.8%)	0 (0.0%)	6 (11.8%)	2 (6.25%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (7.7%)	5 (50)
Treatable/ easily treated	2 (2.1%)	11 (11.0%)	19 (20.0%)	1 (1.5%)	4 (7.8%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	6 (37)
Inhibits grazing/ causes wasting	0 (0.0%)	4 (4.0%)	6 (6.3%)	1 (1.5%)	13 (25.5%)	0 (0.0%)	0 (0.0%)	1 (3.8%)	2 (11.1%)	0 (0.0%)	7 (27)
High mortality rate	7 (7.4%)	4 (4.0%)	0 (0.0%)	7 (10.8%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (3.8%)	0 (0.0%)	2 (15.4%)	8 (21)
High infection rate	6 (6.3%)	2 (2.0%)	0 (0.0%)	0 (0.0%)	3 (5.9%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	9 (11)
Rarely/ not fatal	0 (0.0%)	0 (0.0%)	4 (4.2%)	0 (0.0%)	5 (9.8%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (7.7%)	10 (10)
Zoonotic	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (7.7%)	8 (44.4%)	0 (0.0%)	10 (10)
Less frequent/common	1 (1.1%)	4 (4.0%)	0 (0.0%)	1 (1.5%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (3.8%)	1 (5.6%)	0 (0.0%)	11 (8)

	Livestock Disease in Order of Self-Reported Community Impact										
Rationale for Ranking	CB/CPP	"ECF"	Tryp.	"Ent."	FMD	Heart-water	Red-water	S&G Pox	Anthr.	"Olodua"	**Ranked Frequency of Rationale**
Causes miscarriage	2 (2.1%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	5 (9.8%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	12 (7)
Other (combination)	1 (1.0%)	1 (1.0%)	9 (9.5%)	4 (6.2%)	2 (3.9%)	6 (18.7%)	0 (0.0%)	1 (3.8%)	0 (0.0%)	1 (7.7%)	13+ (24)
Total	**108**	**87**	**95**	**65**	**51**	**32**	**26**	**26**	**18**	**13**	

Causes of Ranked Diseases

	Livestock Disease in Order of Self-Reported Community Impact										
Identified Cause	CB/CPP	"ECF"	Tryp.	"Ent."	FMD	Heart-water	Red-water	S&G Pox	Anthrax	"Olodua"	**Ranked Frequency of Cause**
IDK	57 (60%)	27 (27%)	9 (9.5%)	36 (55.4%)	19 (37.3%)	10 (31.25%)	8 (30.8%)	16 (61.5%)	11 (61.1%)	6 (46.2%)	**1 (199)**
Tsetse fly	0	2 (2%)	43 (45.3%)	0	0	0	0	0	0	0	**2 (45)**
Air	11 (11.6%)	8 (8.0%)	0	7 (10.8%)	9 (17.6%)	4 (12.5%)	0	2 (7.7%)	0	0	**3 (41)**
Grass/green grass	1 (1.1%)	22 (22.0%)	5 (5.3%)	4 (6.2%)	6 (11.8%)	0	0	0	0	3 (23.1%)	**3 (41)**
Mosquitoes/flies	0	9 (9.0%)	18 (18.9%)	0	0	0	0	0	0	0	**4 (27)**
No answer/ missing record	7 (7.4%)	6 (6.0%)	3 (3.2%)	3 (4.6%)	0	0	1 (3.8%)	1 (3.8%)	2 (11.1%)	1 (7.7%)	**5 (24)**
Ticks	1 (1.1%)	9 (9.0%)	0	1 (1.5%)	0	12 (37.5%)	0	0	0	0	**6 (23)**
Animal-Animal Transmission	6 (6.3%)	0	1 (1.1%)	2 (3.1%)	3 (5.9%)	0	0	3 (11.5%)	0	1 (7.7%)	**7 (16)**
Rain/rainy season	0	8 (8.0%)	1 (1.1%)	2 (3.1%)	0	0	1 (3.8%)	0	1 (5.6%)	0	**8 (13)**
God	3 (3.2%)	3 (3.0%)	3 (3.2%)	0	1 (2.0%)	2 (6.2%)	0	0	0	0	**9 (12)**
Contaminated water	0	3 (3.0%)	0	1 (1.5%)	5 (9.8%)	0	2 (7.7%)	0	0	0	**10 (11)**
Wild animals	2 (2.1%)	0	7 (7.4%)	1 (1.5%)	0	0	0	0	0	1 (7.7%)	**10 (11)**
Bush	0	1 (1.0%)	4 (4.2%)	0	1 (2.0%)	0	2 (7.7%)	0	0	0	**11 (8)**
Minerals/salty places	3 (3.2%)	0	0	1 (1.5%)	0	0	0	1 (3.8%)	2 (11.1%)	1 (7.7%)	**11 (8)**

Identified Cause	CB/CPP	"ECF"	Tryp.	"Ent."	FMD	Heart-water	Red-water	S&G Pox	Anthrax	"Olodua"	**Ranked Frequency of Cause**
Contaminated grass	0	0	0	0	0	1 (3.1%)	7 (26.9%)	0	0	0	**11 (8)**
Dirt/soil/eating soil	1 (1.1%)	0	0	1 (1.5%)	1 (2.0%)	0	2 (7.7%)	0	1 (5.6%)	0	**12 (6)**
Other	4 (4.2%)	2 (2.0%)	1 (1.1%)	6 (9.3%)	6 (11.8%)	3 (9.3%)	3 (10.5%)	4 (15.4%)	1 (5.6%)	1 (7.7%)	**13+ (31)**
Total Responses	**96**	**100**	**105**	**65**	**51**	**32**	**26**	**27**	**18**	**14**	

Best Treatment for Ranked Diseases

	Livestock Disease in Order of Self-Reported Community Impact										
Is there a treatment for this disease	CB/CPP	"ECF"	Tryp.	"Ent."	FMD	Heart-water	Red-water	S&G Pox	Anthrax	"Olodua"	Ranked Frequency/ Total
Yes	80 (84.2%)	88 (88.0%)	92 (96.8%)	42 (64.6%)	32 (62.7%)	18 (56.2%)	18 (69.2%)	19 (73.1%)	9 (50.0%)	11 (84.6%)	409
No	8 (8.4%)	5 (5.0%)	1 (1.1%)	16 (24.6%)	13 (25.5%)	12 (37.5%)	5 (19.2%)	2 (7.7%)	6 (33.3%)	1 (7.7%)	69
IDK	4 (4.2%)	1 (1.0%)	2 (3.9%)	3 (4.6%)	2 (3.9%)	1 (3.1%)	1 (3.8%)	4 (15.4%)	2 (11.1%)	1 (7.7%)	21
No answer	3 (3.2%)	6 (6.0%)	4 (7.8%)	4 (6.2%)	4 (7.8%)	1 (3.1%)	2 (7.7%)	1 (3.8%)	1 (5.6%)	0 (0.0%)	26
Total	**95**	**100**	**99**	**65**	**51**	**32**	**26**	**26**	**18**	**13**	
What is the treatment for this Disease?	CB/CPP (95)	"ECF" (100)	Tryp. (95)	"Ent." (65)	FMD (51)	Heart-water (32)	Red-water (26)	S&G Pox (26)	Anthrax (18)	"Olodua"	
Oxytetracycline	39 (48.8%)	62 (70.5%)	1 (1.1%)	20 (47.6%)	10 (31.2%)	5 (27.8%)	10 (55.6%)	4 (21.4%)	2 (22.2%)	7 (63.6%)	1 (160)
Novidium/ Veriben	2 (2.5%)	3 (3.4%)	76 (82.6%)	2 (4.8%)	2 (6.2%)	0 (0.0%)	3 (16.7%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (88)
Did not answer	11 (13.8%)	16 (18.2%)	14 (15.2%)	3 (7.1%)	4 (12.5%)	5 (27.8%)	1 5.6%)	9 (47.4%)	2 (22.2%)	1 (9.1%)	3 (66)
Govt./Vet has	18 (22.5%)	1 (1.1%)	0 (0.0%)	4 (9.5%)	10 (31.2%)	0 (0.0%)	0 (0.0%)	2 (10.5%)	3 (33.3%)	0 (0.0%)	4 (38)
Penicillin	3 (3.8%)	5 (5.7%)	1 (1.1%)	5 (11.9%)	2 (6.2%)	4 (22.2%)	2 (11.1%)	0 (0.0%)	1 (11.1%)	2 (18.2%)	5 (25)
I don't know	5 (6.3%)	1 (1.1%)	0 (0.0%)	6 (14.3%)	1 (3.1%)	1 (5.6%)	2 (11.1%)	1 (5.3%)	0 (0.0%)	1 (9.1%)	6 (18)

What is the treatment for this Disease?	CB/CPP (95)	"ECF" (100)	Tryp. (95)	"Ent." (65)	FMD (51)	Heart-water (32)	Red-water (26)	S&G Pox (26)	Anthrax (18)	"Olodua"	
Agrovet shop/ Chemist has	2 (2.5%)	1 (1.1%)	0 (0.0%)	2 (4.8%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (5.3%)	0 (0.0%)	0 (0.0%)	7 (6)
Not available/ not accessible	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	3 (16.7%)	0 (0.0%)	2 (10.5%)	1 (11.1%)	0 (0.0%)	8 (6)
Trad. medicine	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (6.2%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	9 (2)
Passes naturally	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (3.1%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	10 (1)
Total	**80**	**88**	**92**	**42**	**32**	**18**	**18**	**19**	**9**	**11**	

Appendix D Human Disease Prioritization and Understanding

Rationale for Ranking

Human Disease in Order of Self-Reported Community Impact											
Rationale for ranking	Mal.	Typh.	Bruc.	CC	Pneum.	HIV	Arthritis.	TB	STI	GI	**Ranked Frequency of Rationale**
Inhibits functioning	17 (14.3%)	39 (60.9%)	41 (64.1%)	15 (25.9%)	8 (25.8%)	0 (0.0%)	12 (75.0%)	3 (33.3%)	5 (62.5%)	0 (0.0%)	1 (140)
Causes fatalities	45 (37.8%)	5 (7.8%)	2 (3.1%)	2 (3.4%)	18 (58.1%)	2 (11.8%)	0 (0.0%)	3 (33.3%)	0 (0.0%)	3 (33.3%)	2 (80)
Common/endemic	20 (16.8%)	2 (3.1%)	5 (7.8%)	14 (24.1%)	1 (3.2%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (22.2%)	3 (44)
Difficult/impossible to treat	2 (1.7%)	2 (3.1%)	8 (12.5%)	0 (0.0%)	0 (0.0%)	13 (76.5%)	0 (0.0%)	2 (22.2%)	0 (0.0%)	0 (0.0%)	4 (27)
Missing	8 (6.7%)	3 (4.7%)	4 (6.3%)	3 (5.2%)	2 (6.5%)	1 (5.9%)	1 (6.3%)	0 (0.0%)	0 (0.0%)	1 (11.1%)	5 (23)
Other	11 (9.2%)	2 (3.1%)	0 (0.0%)	6 (10.3%)	0 (0.0%)	0 (0.0%)	3 (18.8%)	0 (0.0%)	0 (0.0%)	1 (11.1%)	6 (23)
Rarely/not fatal	0 (0.0%)	0 (0.0%)	0 (0.0%)	14 (24.1%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	7 (14)
Lack of clean water	1 (0.8%)	6 (9.4%)	0 (0.0%)	2 (3.4%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	8 (9)
Slow recovery	1 (0.9%)	3 (4.7%)	1 (1.6%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (25.0%)	0 (0.0%)	9 (7)
Treatable	5 (4.2%)	1 (1.6%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	10 (6)

Human Disease in Order of Self-Reported Community Impact											
Rationale for ranking	Mal.	Typh.	Bruc.	CC	Pneum.	HIV	Arthritis.	TB	STI	GI	**Ranked Frequency of Rationale**
Rapid onset	4 (3.4%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	11 (4)
Seasonal	2 (1.7%)	0 (0.0%)	0 (0.0%)	1 (1.7%)	1 (3.2%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	12 (4)
Dangerous in children	1 (0.8%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (3.2%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (11.1%)	13 (3)
IDK	2 (1.7%)	1 (1.6%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	14 (3)
Slow progression/onset	0 (0.0%)	0 (0.0%)	1 (1.6%)	1 (1.7%)	0 (0.0%)	1 (5.9%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	15 (3)

Causes of Ranked Diseases

Human Disease in Order of Self-Reported Community Impact											
Identified Cause	Mal.	Typh.	Bruc.	CC	Pneum.	HIV	Arthritis	TB	STI	GI	**Ranked Frequency of Cause**
IDK	14 (11.8%)	6 (9.4%)	21 (32.8%)	14 (24.1%)	4 (12.9%)	0 (0.0%)	8 (50.0%)	4 (44.4%)	0 (0.0%)	1 (11.1%)	1 (72)
Mosquito	53 (44.5%)	1 (1.6%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (54)
Dirty water	7 (5.9%)	35 (54.7%)	1 (1.6%)	1 (1.7%)	0 (0.0%)	0 (0.0%)	1 (6.3%)	0 (0.0%)	0 (0.0%)	2 (22.2%)	3 (47)
Unboiled milk	10 (8.4%)	2 (3.1%)	32 (50.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	4 (44)
Air	6 (5.0%)	1 (1.6%)	0 (0.0%)	16 (27.6%)	15 (48.4%)	0 (0.0%)	2 (12.5%)	0 (0.0%)	1 (12.5%)	0 (0.0%)	5 (41)
Missing	6 (5.0%)	5 (7.8%)	2 (3.1%)	10 (17.2%)	1 (3.2%)	1 (5.9%)	3 (18.8%)	0 (0.0%)	1 (12.5%)	2 (22.2%)	6 (31)
Dirt	0 (0.0%)	4 (6.3%)	0 (0.0%)	7 (12.1%)	1 (3.2%)	0 (0.0%)	2 (12.5%)	0 (0.0%)	0 (0.0%)	3 (33.3%)	7 (17)
Rainy season	12 (10.1%)	1 (1.6%)	0 (0.0%)	3 (5.2%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	8 (16)
Sexual intercourse	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	12 (70.6%)	0 (0.0%)	0 (0.0%)	4 (5.0%)	0 (0.0%)	9 (16)
Other	2 (1.7%)	2 (3.1%)	1 (1.6%)	2 (3.4%)	0 (0.0%)	2 (11.8%)	1 (6.3%)	4 (44.4%)	2 (25.0%)	0 (0.0%)	11 (13)
Cold season	2 (1.7%)	0 (0.0%)	0 (0.0%)	3 (5.2%)	8 (25.8%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	10 (13)
Diseased livestock	0 (0.0%)	0 (0.0%)	6 (9.4%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	12 (6)

Human Disease in Order of Self-Reported Community Impact											
Identified Cause	Mal.	Typh.	Bruc.	CC	Pneum.	HIV	Arthritis	TB	STI	GI	**Ranked Frequency of Cause**
Dirty food	0 (0.0%)	4 (6.3%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (11.1%)	13 (5)
God	1 (0.8%)	1 (1.6%)	1 (1.6%)	2 (3.4%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	14 (5)
Other disease	2 (1.7%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (6.5%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	15 (4)
Certain foods	0 (0.0%)	3 (4.7%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (11.1%)	0 (0.0%)	0 (0.0%)	16 (4)
Green grass	3 (2.5%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	17 (3)
Viruses	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (1.7%)	0 (0.0%)	2 (11.8%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	18 (3)

Best Treatment for Prioritized Diseases

Human Disease in Order of Self-Reported Community Impact										
Is there a treatment for this disease?	Mal.	Typh.	Bruc.	CC	Pneum.	HIV	Arthritis	TB	STI	GI
Yes	112 (94.1%)	56 (92.2%)	59 (92.2%)	48 (82.8%)	29 (93.5%)	0 (0.0%)	15 (93.8%)	9 (100.0%)	7 (87.5%)	6 (66.7%)
No	0 (0.0%)	3 (4.7%)	2 (3.1%)	3 (5.2%)	0 (0.0%)	14 (82.4%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
IDK	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (11.8%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Missing	6 (5.0%)	4 (6.3%)	3 (4.7%)	5 (8.6%)	2 (6.5%)	1 (5.9%)	2 (12.5%)	0 (0.0%)	0 (0.0%)	1 (11.1%)
What is the treatment?	Mal.	Typh.	Bruc.	CC	Pneum.	HIV	Arth.	TB	STI	GI
No answer	48 (42.9%)	32 (57.1%)	30 (50.8%)	10 (20.8%)	17 (58.6%)	0 (0.0%)	6 (40.0%)	9 (100.0%)	2 (28.6%)	3 (50.0%)
Clinic treatment	56 (50.0%)	23 (41.1%)	29 (49.2%)	21 (43.8%)	10 (34.5%)	0 (0.0%)	9 (60.0%)	0 (0.0%)	3 (42.9%)	1 (16.7%)
Traditional herbs	8 (7.1%)	1 (1.8%)	0 (0.0%)	17 (35.4%)	2 (6.9%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (28.6%)	2 (33.3%)