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Sustainable livestock systems in Ethiopia:

Assessment of the status quo and options for improvement with a focus on animal welfare, market systems, gender roles and human-wildlife conflict management

Dissertation
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DECLARATION

According to the §17 of the Doctoral Examinations Regulations of the Faculty 09, from July 7th, 2004, it last changed on May 29th, 2019
I declare: this dissertation is a work of my own, written without any illegitimate help by any third party and only with materials indicated in the dissertation. I have indicated in the text where I have used texts from already published sources, either word for word or in substance, and where I have made statements based on oral information given to me. At any time during the investigations carried out by me and described in the dissertation, I followed the principles of good scientific practice as defined in the "statutes of the Justus-Liebig University Giessen for the safeguarding of the good scientific practice".

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Date Applicant

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Table of Contents

List of tables

List of figures

List of Abbreviations

ANOVA	Analysis of Variance
AWS	Animal Welfare Standards
CD	Contract Duration
CI	Community Involvement
CR	Certification and Recognition
CSA	Central Statistical Agency
DCE	Discrete Choice Experiment
FAO	Food and Agriculture Organization
FFF	Five Freedoms Framework
FI	Financial Incentives
HWC	Human-Wildlife Conflict
IQR	Interquartile Range
ILRI	International Livestock Research Institute
MXL	Mixed Logit Model
RUT	Random Utility Theory
SPSS	Statistical Package for the Social Sciences
SAWA	Synergies of Animal Welfare and Agroforestry
SSA	Sub-Saharan Africa
TLU	Tropical Livestock Unit
USD	United States Dollar
WTA	Willingness to Accept

Summary

This study brings together three strands of research to provide a holistic understanding of animal welfare challenges and opportunities in Ethiopia, focusing on farmers' willingness to engage in welfare initiatives, market-level welfare conditions, and traditional methods for managing human-wildlife conflict. Together, these findings offer critical insights for policy and program development aimed at improving both animal well-being and rural livelihoods.

The first chapter explores farmers' preferences and willingness to participate in voluntary animal welfare schemes using mixed logit models in preference and willingness to pay space to assess the relative importance of different attributes of animal welfare schemes on farm households' participation. Results show that financial incentives are the most significant factor influencing participation. Farmers indicated a need for compensation equivalent to 11% of their annual livestock sales to participate in welfare programs. More demanding welfare improvements such as optimal welfare standards or improved training required significantly higher compensation, up to 25–26% of livestock sales per year. These findings underline the importance of aligning welfare improvements with tangible economic benefits to ensure farmer engagement. Policy recommendations include the development of flexible, farmer-oriented schemes that combine financial incentives with accessible training and community-based approaches.

The second chapter assesses the state of animal welfare in three livestock markets: Addis Ababa (terminal), Adama (secondary), and Meki (local). The analysis reveals substantial variation in infrastructure and animal handling practices. While the terminal market offers relatively humane conditions and access to basic amenities such as water and shelter, the local and secondary markets lack such facilities and are characterized by poor handling practices, including forceful movement and lack of rest. These conditions contribute to animal stress and injury, undermining both welfare and market efficiency. Additionally, the study highlights gender inequalities in market participation, with women facing systemic barriers. To address these challenges, the study recommends investment in welfare-supportive infrastructure, implementation of enforceable national welfare standards, comprehensive training for handlers, and policies that actively promote gender inclusion.

The third chapter focuses on human-wildlife conflict around Nech Sar National Park, analyzing the economic and social impact of livestock predation and crop damage. Households within 16 kilometers of the park suffer average annual losses of $76.78, which is approximately 77% of their annual income, due to wildlife incursions. While traditional guarding practices are widely used, most respondents viewed them as ineffective unless rigorously applied. Gender differences were also evident: male-headed households experienced greater cattle losses, while female-headed households were more affected by poultry predation which reflects differences between genders in species kept. The findings emphasize the need for a combination of modern and traditional strategies, including expanded buffer zones, improved fencing, gender-sensitive planning, and community engagement to reduce conflict and protect livelihoods.

Taken together, these three studies provide a comprehensive picture of the multifaceted issues affecting animal welfare and rural livelihoods in Ethiopia. They underscore the importance of integrating financial incentives, infrastructure investment, gender equity, and local knowledge into national policy. By addressing the economic factors of farmers, improving market conditions, and supporting community-based conservation, Ethiopia can move toward more sustainable and inclusive animal welfare systems.

Zusammenfassung

Diese Studie vereint drei Studien, um ein ganzheitliches Verständnis der Herausforderungen und Chancen im Bereich Tierschutz in Äthiopien zu vermitteln. Der Schwerpunkt liegt dabei auf der Bereitschaft der Landwirte, sich an Tierschutzinitiativen zu beteiligen, den Tierschutzbedingungen auf Marktebene und traditionellen Methoden zum Umgang mit Konflikten zwischen Mensch und Wildtieren. Zusammen bieten diese Ergebnisse wichtige Erkenntnisse für die Entwicklung von Strategien und Programmen, die sowohl das Wohlergehen der Tiere als auch die Lebensgrundlagen im ländlichen Raum verbessern sollen.

Der erste Kapitel untersucht die Präferenzen und die Bereitschaft der Landwirte, sich an freiwilligen Tierschutzprogrammen zu beteiligen, unter Verwendung gemischter Logit-Modelle im Bereich der Präferenzen und der Zahlungsbereitschaft, um die relative Bedeutung verschiedener Merkmale von Tierschutzprogrammen für die Beteiligung landwirtschaftlicher Haushalte zu bewerten.

Die Ergebnisse zeigen, dass finanzielle Anreize der wichtigste Faktor sind, der die Teilnahme beeinflusst. Die Landwirte gaben an, dass sie eine Entschädigung in Höhe von 11 % der Geldsummen ihres jährlichen Viehverkaufs benötigen, um an Tierschutzprogrammen teilzunehmen. Anspruchsvollere Verbesserungen des Tierschutzes, wie optimale Tierschutzstandards oder verbesserte Schulungen, erforderten eine deutlich höhere Entschädigung von bis zu 25–26 % des jährlichen Viehverkaufs. Diese Ergebnisse unterstreichen, wie wichtig es ist, Verbesserungen des Tierschutzes mit konkreten wirtschaftlichen Vorteilen zu verbinden, um das Engagement der Landwirte sicherzustellen. Zu den politischen Empfehlungen gehört die Entwicklung flexibler, landwirtorientierter Programme, die finanzielle Anreize mit zugänglichen Schulungen und gemeindebasierten Ansätzen kombinieren.

Der zweite Kapitel bewertet den Zustand des Tierschutzes auf drei Viehmärkten: Addis Abeba (Endmarkt), Adama (Sekundärmarkt) und Meki (lokaler Markt). Die Analyse zeigt erhebliche Unterschiede in der Infrastruktur und den Praktiken im Umgang mit Tieren. Während der Endmarkt relativ humane Bedingungen und Zugang zu grundlegenden Einrichtungen wie Wasser und Unterkünften bietet, fehlen solche Einrichtungen auf den lokalen und sekundären Märkten, die außerdem durch schlechte Praktiken im Umgang mit Tieren gekennzeichnet sind, darunter gewaltsame Bewegungen und mangelnde Ruhezeiten. Diese Bedingungen tragen zu Stress und Verletzungen der Tiere bei und beeinträchtigen sowohl das Wohlergehen als auch die

Markteffizienz. Darüber hinaus hebt die Studie geschlechtsspezifische Ungleichheiten bei der Marktteilnahme hervor, wobei Frauen mit systemischen Hindernissen konfrontiert sind. Um diese Herausforderungen anzugehen, empfiehlt die Studie Investitionen in eine tierfreundliche Infrastruktur, die Umsetzung durchsetzbarer nationaler Tierschutzstandards, umfassende Schulungen für Tierhalter und Maßnahmen, die die Gleichstellung der Geschlechter aktiv fördern.

Der dritte Kapitelkonzentriert sich auf Konflikte zwischen Mensch und Wildtieren rund um den Nech Sar Nationalpark und analysiert die wirtschaftlichen und sozialen Auswirkungen von Prädation und Ernteschäden durch Wildtiere. Haushalte im Umkreis von 16 Kilometern um den Park erleiden aufgrund von Wildtierangriffen durchschnittliche jährliche Verluste in Höhe von 76,78 US-Dollar, was etwa 77 % ihres Jahreseinkommens entspricht. Obwohl traditionelle Schutzmaßnahmen weit verbreitet sind, hielt die Mehrheit der Befragten diese für unwirksam, sofern sie nicht rigoros angewendet werden. Auch geschlechtsspezifische Unterschiede waren offensichtlich: Haushalte mit männlichem Haushaltsvorstand verzeichneten größere Verluste an Rindern, während Haushalte mit weiblichem Haushaltsvorstand stärker von Raubtierangriffen auf Geflügel betroffen waren, was die ungleiche Verteilung der gehaltenen Tierarten zwischen den Geschlechtern widerspiegelt. Die Ergebnisse unterstreichen die Notwendigkeit einer Kombination aus modernen und traditionellen Strategien, darunter erweiterte Pufferzonen, verbesserte Zäune, geschlechtersensible Planung und Einbindung der Gemeinschaft, um Konflikte zu reduzieren und Lebensgrundlagen zu schützen.

Zusammengenommen liefern diese drei Studien ein umfassendes Bild der vielfältigen Probleme, die das Wohlergehen von Tieren und die Lebensgrundlagen im ländlichen Raum in Äthiopien beeinträchtigen. Sie unterstreichen, wie wichtig es ist, finanzielle Anreize, Investitionen in die Infrastruktur, Geschlechtergerechtigkeit und lokales Wissen in die nationale Politik zu integrieren. Durch die Berücksichtigung der wirtschaftlichen Realitäten der Landwirte, die Verbesserung der Marktbedingungen und die Unterstützung gemeindebasierter Naturschutzmaßnahmen kann Äthiopien zu nachhaltigeren und inklusiveren Tierschutzsystemen gelange.

Chapter 1. Introduction

Animal welfare, sustainable livestock management, and human-wildlife interactions are deeply interwoven elements in the broader context of agriculture, food security, and rural development. In Ethiopia where agriculture is the mainstay of livelihoods for the majority of small holders' farmers, these issues are especially pressing. This dissertation brings together three related studies, each using different methods, to explore key issues in animal welfare and sustainable livestock systems in smallholder farms.

1.1. Animal welfare and smallholder livelihoods

Motivated by the increasing emphasis on healthier lifestyles and environmental stewardship, ethical food choices are increasingly influencing global food purchasing behaviors (Fanzo, 2015; O'Connor et al., 2017). Ethical consumption integrates moral considerations within the domain of global food security, including the assurance of nutritional inclusivity, addressing malnutrition, and harmonizing environmental sustainability with individual dietary requirements, particularly in relation to resource-intensive animal-source foods (Ghvanidze et al., 2017; Grummon et al., 2020). Consequently, animal welfare has long been a key policy concern in developed economies, and it is gaining increasing prominence in policy debates across the developing world(von Keyserlingk and Hötzel, 2015; Parlasca *et al.*, 2023).

Animal welfare plays a central role in sustainable agriculture, food security, and ethical treatment of animals. Globally, improved animal welfare is increasingly recognized not only as a moral imperative, but also as an economic and ecological necessity (Gibson and Jackson, 2017; Richter et al., 2024). Enhancing animal welfare by ensuring sufficient feed and water, access to veterinary care, and mitigating stress through proper housing and workload management not only improves livestock health and productivity but also fosters food security and economic resilience among rural households (Pradère, 2014; Sacarrão-Birrento et al., 2024). In many countries in the Global South, consumer demand for ethically produced animal products is increasing, particularly in urban areas, while export-oriented markets are increasingly shaped by international standards and welfare guidelines such as those codified in the OIE's Terrestrial Animal Health Code (Jukan et al., 2017)

Livestock in developing countries are predominantly valued for their contributions to human livelihoods, which means welfare advancements often gain traction primarily when associated with clear economic advantages (Balzani and Hanlon, 2020; Mugenda and Croney, 2019). Based on a review of six national studies on pig farms, Bock and Van Huik (2007) reported that the most important barrier to participating in specific animal welfare schemes was farmers' distrust in the economic advantages of doing so. Yet, the economic justification for animal welfare is often underexplored in developing economies, where smallholder farmers face complex trade-offs between immediate survival needs and long-term productivity (Njisane et al., 2020; Parlasca et al., 2023).

With an estimated livestock population of about 70.3 million cattle, 42.9 million sheep, 52.5 million goats and 1.6 million camels (Countryman et al., 2024) Ethiopia possesses one of the largest livestock herds in Africa. Given the millions of people whose livelihoods depend on this sector, the importance of animal welfare in the Ethiopian context is considerable. Nevertheless, the development and implementation of animal welfare initiatives face substantial challenges. Awareness and concern for animal welfare remain limited among most actors along the Ethiopian livestock value chain (Gobena and Kumsa, 2020).

As they are the main custodians of livestock in the country, farmers' lack of knowledge is a critical challenge (Alemayehu et al., 2022a; Njisane et al., 2020). Based on a systematic review of the relevant literature over a period of 30 years, (Balzani and Hanlon, 2020b) emphasized that farmers' knowledge, skills and abilities were amongst the most important factors that influenced the implementation of animal welfare enhancing practices. Many farmers are also unable to invest in these practices, resulting in the continued reliance on traditional livestock production methods that often neglect animal welfare (Boyle et al., 2022; Phillips, 2024). This lack of knowledge and investment is further complicated by the absence of legislation enforcement, while training in animal handling often falls short of covering animal welfare issues (Alemayehu *et al.*, 2022; Lemma *et al.*, 2019).

As is the case for many developing countries the discussion around animal welfare issues in Ethiopia is increasingly influenced by export market demand, particularly from the Middle East, where access to high-value trade routes and price premiums depends on compliance with strict welfare and product quality standards (Wakaso et al., 2025). Given the country's heavy dependence on agricultural exports, meeting requirements of the importing countries is a necessity. Nonetheless, smallholder farmers continue to operate with non-commercial intentions, where

animal welfare is not a basis for any price premium. This creates a disconnect between the national level interest in increasing exports and the local economic objectives of smallholder livestock keepers.

The effective design and implementation of animal welfare schemes in Ethiopia requires careful attention to the challenges outlined above, along with the identification or adaptation of proven solutions from similar contexts. These welfare schemes can be understood through their key attributes, with adoption influenced by how different stakeholders such as international buyers (especially in the Middle East), domestic urban consumers, policymakers, NGOs, veterinarians, and research institutions value those attributes. Despite their importance, very few studies have examined producers' preferences, and none were found that estimate producers' marginal willingness to accept (WTA) or willingness to pay (WTP) for animal welfare schemes in a developing country context.

In this context, Study 1 focuses on livestock keepers and conceptualizes animal welfare schemes as quality-differentiated services. A discrete choice experiment is employed to elicit farmers' preferences, and mixed logit models are estimated to quantify the marginal willingness-to-accept (WTA) values of the different scheme attributes. The study setting is distinctive in that it examines preferences within traditional livestock systems, where animals provide multiple functions beyond market-oriented production. Importantly, Ethiopia enacted its first legislation on Animal Health and Welfare in May 2025. The findings of this study are therefore expected to contribute to the design and implementation of animal welfare schemes in the country.

1.2. Market infrastructure and the welfare of small ruminants

Small ruminants specifically sheep and goats are vital to food security, rural income, and cultural identity across Ethiopia and Sub-Saharan Africa. Ethiopia hosts more than 95 million small ruminants and these animals play a central role in rural economies, especially within mixed farming systems (Derbib, 2021). The marketing system for live small ruminants operates in a multi-tiered structure consisting of local, secondary, and terminal markets. These markets differ substantially in infrastructure, regulatory oversight, and welfare conditions (Rebuma et al., 2024).

Local markets function as the initial point of sale for smallholder farmers, typically located within rural communities. Transactions here are largely informal, relying on visual inspection and negotiation, with minimal use of standardized pricing mechanisms (Gobena 2016). Secondary markets serve as intermediate hubs, aggregating animals from multiple local markets for reselling to larger-scale traders or intermediaries. These markets often require long-distance transport,

which can lead to increased costs and welfare concerns such as weight loss due to stress (Gemeda et al., 2009). Terminal markets, located in urban centers, are characterized by larger volumes and more competitive pricing. They attract exporters, retailers, and slaughterhouses willing to pay premiums for high-quality animals (Kocho et al., 2011). Despite their economic importance, these marketing systems face persistent challenges, including high transaction costs, price volatility, and limited access to reliable market information (Jabbar et al., 2008). Despite the existence of relevant legislation such as Proclamation No. 819/2006 and Regulation No. 341/2015 implementation remains uneven, and animal welfare violations are common.

Study 2 evaluates small ruminant welfare across this marketing chain by focusing on selected markets in Meki city (local market), Adama city (secondary) and Addis Ababa (terminal). It investigates whether improved infrastructure and regulatory compliance in terminal markets correspond to better animal handling practices, testing the hypothesis that market tier correlates with welfare outcomes. Additionally, it considers socio-economic factors, such as gender and accessibility, that influence market participation and animal treatment. Findings reveal frequent deviations from the Five Freedoms of Animal Welfare, particularly in the areas of discomfort and behavioral restriction suggesting a need for stronger regulatory enforcement and handlers training.

1.3. Human-Wildlife conflict and livestock sustainability

Beyond the livestock value chain, rural livelihoods in Ethiopia are also affected by interactions with wildlife particularly near conservation areas. Human-wildlife conflicts (HWC) occur when human activities and wildlife interactions lead to negative consequences for either humans or wildlife, or both. These conflicts have significant socio-economic implications, particularly on the livelihoods of communities residing in and around protected areas such as the Nech Sar National Park in Ethiopia (Ahmedin, 2020). Nech Sar National Park is renowned for its diverse wildlife, including various bird species, mammals, and unique ecosystems, making it a vital conservation area in the country of Ethiopia (MOT, 2023). Conflicts arise not only due to attacks on livestock and humans, but also due to competition for resources, such as water, grazing lands, and crops. As a result, these conflicts can negatively impact the well-being and economic stability of the communities dependent on the park's resources and surrounding areas for their livelihoods (Mekonen, 2020). A study conducted by Gonste et al. (2018) in the region highlights the recurrent encounters with wildlife that affected households, leading to reduced crop yields (e.g., due to crop raiding by elephants), increased production costs from the need for protective measures, and

livestock losses due to predation all of which significantly contributed to economic losses for farmers (Gontse et al., 2018).

Moreover, the impact of human-wildlife conflicts extends beyond immediate economic losses, influencing social and psychological aspects of the communities in the region, and predation poses a major threat to livestock welfare. Research by Braczkowski et al. (2023) reveals that prolonged exposure to such conflicts can lead to heightened stress levels and anxiety among farmers. The uncertainty and unpredictability associated with wildlife encroachment create feelings of vulnerability and fear, affecting mental health and overall well-being. Additionally, communities may face social disintegration as disputes over resources and conservation measures strain relationships among farmers and with conservation authorities (Braczkowski et al., 2023).

As Nech Sar National Park authorities endeavor to protect the park's rich biodiversity and unique ecosystems, finding sustainable solutions to mitigate human-wildlife conflicts becomes imperative for fostering harmonious coexistence. Acknowledging the socio-economic consequences of these conflicts on Agro-based livelihoods is crucial for implementing effective policies and community-based initiatives.

Study 3 explore existing solutions for reducing human-wildlife conflicts in and around Nech Sar National Park. It specifically focuses on the socio-economic benefits of traditional housing and guarding methods as strategies to minimize conflicts and support farming practices. Additionally, the study examines how economic incentive-based livestock housing can contribute to environmental conservation and sustainable livestock management.

Together, the three studies presented in this dissertation provide a multi-scalar analysis of animal welfare and rural sustainability in Ethiopia. They examine welfare both on-farm and off-farm (Study 1 and 2), and they extend the discussion into the human-wildlife interface (Study 3), showing that sustainable livestock management cannot be understood in isolation. Policies, infrastructure, cultural norms, ecological constraints, and market incentives all intersect in shaping outcomes for animals and people alike.

This dissertation contributes to scientific and policy literature by addressing key empirical gaps in three areas: smallholder farmers' willingness to adopt animal welfare practices, welfare conditions along livestock market chains, and the role of human-wildlife dynamics in rural sustainability. It provides evidence-based insights that respond to a lack of context-specific data from low-income, livestock-dependent settings. By integrating economic, cultural, and ecological perspectives, the dissertation emphasizes the need for locally grounded, cross-sectoral solutions

that align with the socio-economic factors and priorities of smallholder communities. The remainder of the dissertation is organized as follows: each subsequent chapter presents one of the three studies in full, including background, literature review, methodology, results, and discussion, followed by a concluding synthesis that draws cross-cutting lessons for animal welfare and rural development policy in Ethiopia.

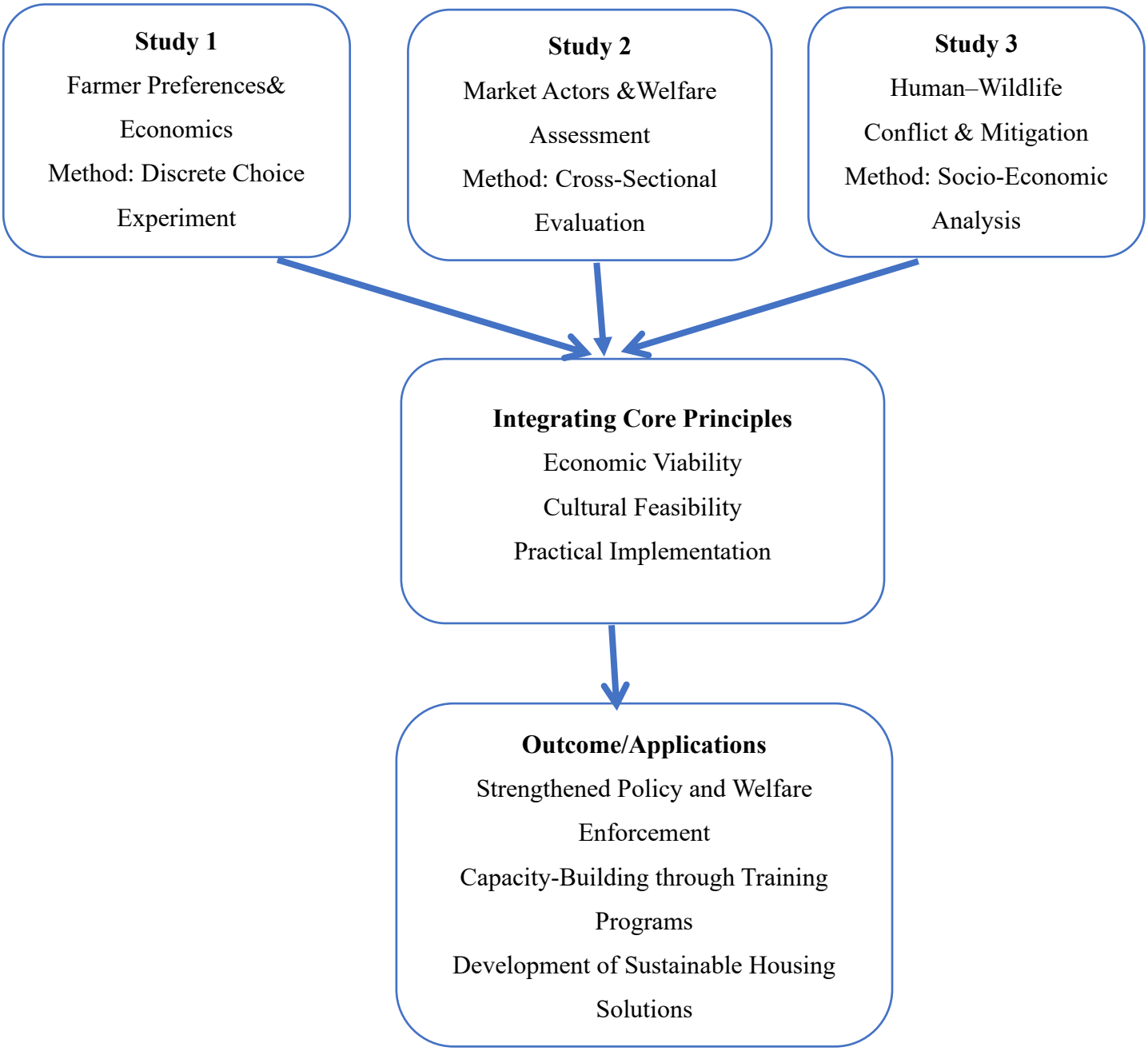

Figure 1: Conceptual framework of the three interrelated studies

Chapter 2. Literature Review

2.1. Global perspectives on animal welfare

Animal welfare has emerged as a central theme in global discussions on sustainable agriculture, food safety, ethical treatment of animals, and economic development. The global discourse increasingly aligns animal welfare with the United Nations Sustainable Development Goals (SDGs), particularly those focusing on zero hunger, good health, responsible consumption, and climate action (Webster and Margerison, 2022). High-income countries have made significant progress in implementing formal animal welfare legislation and standards, often influenced by ethical concerns and consumer demand for high-welfare products (Broom, 2010). European Union directives, for example, have been instrumental in shaping farm practices, including space requirements, transport protocols, and slaughter methods (Fraser, 2008).

The Five Freedoms Framework (FFF), originally formulated by the UK's Farm Animal Welfare Council, has become a global benchmark for assessing animal welfare. These include freedom from hunger and thirst; discomfort; pain, injury, or disease; to express normal behavior; and from fear and distress (McCulloch, 2013). While the FFF has attracted criticism for its conceptual breadth and its tendency toward anthropomorphic framing, it nonetheless retains considerable traction within policy discourse. Its influence is evident to the extent international organizations, national governments, and non-governmental actors continue to invoke the framework when formulating sustainability strategies, biodiversity action plans, and environmental assessment criteria. This uptake is typically operationalized not through legally binding instruments, but via its incorporation into target-setting exercises, evaluative benchmarks for funding allocation, and the alignment of domestic policies with international sustainability commitments. (Mellor 2016).

Market mechanisms and economic incentives are increasingly recognized as effective tools in promoting animal welfare. For instance, voluntary certification schemes such as "Certified Humane" or "Animal Welfare Approved" in North America offer premiums to producers adhering to welfare standards (Swanson, 2024).

Numerous studies have shown that poor animal welfare such as exposure to harsh climates, disease, or stress from poor handling leads to lower productivity in terms of meat, milk, and reproductive performance (Dwyer, 2020). Improving welfare can thus enhance food availability, reduce economic losses, and lower the risk of zoonotic disease transmission. Furthermore, animal welfare improvements often translate into economic benefits at both household and national levels.

For example, healthy and stress-free animals tend to have better feed conversion efficiency and lower mortality, reducing the cost of production while increasing outputs. This is especially critical in fragile pastoralist systems, where livestock loss can lead to immediate livelihood collapse.

Animal welfare in the global south

Animal welfare in developing countries is shaped by a complex intersection of cultural practices, economic constraints, and institutional limitations. Although enhanced welfare is linked to improved livestock health and productivity, the initial investments required—such as veterinary services, quality feed, and adequate shelter often exceed the means of resource-limited farmers. In subsistence farming systems, where income is volatile and immediate survival takes precedence, long-term gains from improved welfare are frequently deprioritized. Unlike high-income countries with enforceable welfare standards, many low- and middle-income nations struggle with weak regulatory frameworks and limited implementation capacity (Choquette-Levy et al., 2024). As a result, the adoption of welfare-oriented practices hinges not only on farmer awareness but also on the presence of external support mechanisms, including financial aid, technical knowledge, and infrastructure.

In regions such as South Asia, Latin America, and Sub-Saharan Africa, traditional farming systems are prevalent and typically focused on meeting short-term subsistence needs, often at the expense of animal welfare (Assan, 2023). Welfare improvements, when they do occur, are seldom farmer-led and are more commonly introduced through external actors such as international donors, NGOs, or compliance with trade requirements, rather than through domestic policy initiatives (David, 2014a). This externally driven approach underscores the persistent gap between the theoretical economic advantages of animal welfare and the practical barriers to its implementation.

Financial and non-financial incentives have been shown to enhance farmer engagement in adopting welfare-enhancing practices. For example, Ola et al. (2019) found that ecosystem service payments (ESPs) that incorporate cultural values and compensate for opportunity costs were more effective in promoting conservation behaviors, including those aligned with animal welfare. In this context, ESPs offer a mechanism to bridge the gap between subsistence priorities and long-term sustainability goals by internalizing the benefits of improved welfare. Such incentive-based schemes may be particularly relevant in traditional systems where market-based or regulatory drivers are weak or absent.

Animal welfare in Sub-Saharan Africa (SSA) is influenced by a heterogeneous mix of policy frameworks, institutional capacities, and cultural perceptions. While countries such as South Africa

and Kenya have incorporated animal welfare into national legislation, many others struggle with weak governance structures and underdeveloped infrastructure, limiting effective implementation (Sinclair et al., 2022). Cultural norms that primarily value livestock as economic assets further constrain the prioritization of welfare considerations (Qekwana et al., 2019).

The relevance of universal frameworks like the Five Freedoms (FFF) in SSA remains contested. Although widely accepted in theory, the FFF often fails to align with the socio-economic factors of many rural communities. More context-specific strategies—focusing on attainable, incremental improvements such as providing shade and water in semi-arid regions tend to be more practical and impactful (Blokhuis et al., 2003).

Policy interventions such as community-based livestock initiatives and participatory extension systems have demonstrated potential; however, their benefits are often concentrated among relatively well-resourced farmers with better access to knowledge and services (Haile et al., 2019). Ethiopia, which holds the continent's largest livestock population, exemplifies these tensions. Despite the sector's critical role in livelihoods, widespread adoption of welfare practices remains limited, particularly among smallholders with low levels of awareness and institutional support (Asmare, 2014).

Previous studies show that Ethiopian farmers lack awareness of welfare standards and often do not perceive direct economic benefits from improved welfare (Hadush, 2018). There is also a significant gap in extension services and training, which limits the dissemination of welfare-related knowledge (Alemayehu et al., 2022a).

Ethiopia's policy framework is still evolving. Although the country is a signatory to international treaties like the World Organization for Animal Health's Terrestrial Code, enforcement mechanisms remain weak. Institutional overlaps and limited budget allocations further restrict progress (Mengistie, 2020). The integration of animal welfare into national policy frameworks remains limited in many developing countries, including Ethiopia. However, international models offer guidance. For example, Australia and New Zealand have adopted animal welfare assurance schemes linked to market access and export eligibility (Grandin, 2010a). These models demonstrate how regulatory frameworks, coupled with capacity-building and certification schemes, can drive improvements.

Animal welfare in livestock markets

Animal welfare in livestock trading systems has become an increasingly prominent issue in both scientific and policy discussions worldwide. Globally, markets remain crucial nodes in the livestock value chain, where animals undergo significant stress due to poor infrastructure, handling, and transportation practices (Gallo and Huertas, 2016; Grandin, 2020). Despite global commitments to ethical animal treatment, empirical studies reveal persistent violations of welfare standards, especially in low- and middle-income countries.

Poor welfare practices during marketing not only compromise ethical standards but also negatively affect product quality and economic returns. For instance, pre-slaughter stress leads to elevated cortisol levels and poor meat quality (Sullivan et al., 2023). Stress-related impacts include dark, firm, and dry (DFD) meat, which is less acceptable to consumers and fetches lower market prices (Jardim et al., 2022). These findings underscore the interdependence of welfare and profitability, thus justifying welfare improvements not only from an ethical standpoint but also from an economic perspective.

The African context mirrors many of the global challenges with additional constraints due to limited infrastructure investment and regulatory enforcement. In Sub-Saharan Africa, small ruminants are essential for livelihoods, food security, and cultural functions (Armson et al., 2020). However, marketing systems remain poorly developed. Research from Tanzania, Uganda, and Nigeria consistently reports welfare violations in livestock markets, including overcrowding, forceful handling, and lack of access to feed and water (Adeboun et al., 2022). Market-related welfare assessments in Southern and Eastern Africa reveal limited compliance with basic welfare provisions. For example, Gallo and Huertas (2016) observed that many African livestock markets lack even rudimentary shelter and watering infrastructure. Moreover, animal loading and unloading are often manual, with handlers lacking proper training. These practices not only heighten animal stress but also reduce trader profitability due to increased mortality and lower product quality (Padalino et al., 2018).

Ethiopia hosts one of the largest small ruminant populations in Africa and has a dynamic multi-tier livestock marketing system (CSA, 2021; Legese et al., 2014). Despite this, local, secondary, and terminal markets exhibit stark differences in welfare conditions, with the former often lacking basic infrastructure such as water and shelter (Bulitta et al., 2012; Desta, 2017). Empirical studies of Ethiopian livestock markets reveal consistent issues with welfare. Bulitta et al. (2012) documented high injury and stress levels in animals traded at local markets due to rough handling

and overcrowding. The Ethiopian Live Animals Marketing Proclamation No. 819/2006 and Council of Ministers Regulation No. 341/2015 outline standards for welfare and market operations. However, enforcement remains weak, particularly at the local and secondary levels (Birhanu, 2014).

Infrastructure and animal welfare in livestock markets

Infrastructure is a central determinant of animal welfare at livestock markets. Poor market designs, lack of shelter, insufficient water points, and inadequate loading/unloading ramps have been identified globally as critical welfare constraints (Bulitta et al., 2012; Padalino et al., 2018). Studies from Latin America and Southeast Asia emphasize that suboptimal holding and transport facilities contribute to increased injury, dehydration, and mortality (Gallo & Huertas, 2016). In contrast, markets that provide shaded rest areas, segregated holding pens, and proper transport loading bays record improved welfare outcomes (Grandin, 2008; Phythian et al., 2013).

The provision of appropriate transport vehicles further plays a critical role in minimizing stress and injury. Knowles (1998) found that inappropriate transport duration and vehicle overcrowding are strongly correlated with high mortality and injury rates. Markets lacking regulatory oversight often permit the use of open trucks or non-specialized vehicles, exposing animals to extreme weather and trauma. These challenges are especially acute in countries lacking formal animal transport legislation or enforcement mechanisms.

Gender in livestock marketing and animal welfare

Gender plays a significant role in the livestock value chain, including animal welfare. Studies across Africa demonstrate that women often have lower participation in formal market systems due to structural and socio-cultural barriers (Dulal, 2020; Njuki and Sanginga, 2013). These barriers also limit their access to training and resources that could enhance humane animal handling.

Interestingly, gender differences in attitudes toward animals and welfare practices are increasingly reported. Randler et al. (2021) and Muri et al. (2023) found that women exhibit greater empathy and opposition to animal cruelty, suggesting that increased female participation in livestock markets could improve welfare outcomes. In Ethiopia, empirical data show that women are underrepresented in higher-value segments of the livestock chain, and this marginalization inhibits welfare improvement efforts (Paudyal et al., 2019).

2.2. Discrete Choice Experiments (DCEs)

Discrete Choice Experiments are a survey-based quantitative method used to elicit individual preferences by asking respondents to choose between hypothetical alternatives characterized by different attributes. The foundational assumption is that individuals derive utility from these attributes and make choices to maximize their utility (Culyer, 2014).

The theoretical basis of DCEs lies in Lancaster's theory of consumer choice and McFadden's random utility theory, where choices are modeled probabilistically based on systematic and random components of utility (Street and Viney, 2019). DCEs are especially useful when revealed preferences (actual choices) are not available or feasible to observe, allowing researchers to simulate market-like settings and estimate willingness-to-pay (WTP) or willingness-to-accept (WTA) for various goods or services (Lancsar and Louviere, 2008). Empirical applications of DCEs have spanned diverse sectors including healthcare, transportation, environmental economics, and agriculture, often helping policymakers understand trade-offs individuals make under constrained choices(Howell and Howard, 2018). Methodological challenges persist in DCE research, particularly around experimental design, attribute selection, preference heterogeneity, and response anomalies due to complexity or cognitive fatigue (Oehlmann, 2019).

Discrete choice experiments and farmer preferences

Understanding the preferences and decision-making processes of farmers is central to developing effective agricultural policies, advancing sustainable practices, and improving risk management strategies. DCEs have become a widely used empirical method in agricultural economics for quantifying how farmers make trade-offs between multiple attributes, such as economic returns, environmental outcomes, and production risks.

DCEs offer a structured approach to eliciting preferences, enabling researchers to analyze the relative importance of different policies and market attributes from the farmer's perspective. Their application has expanded significantly in recent years, particularly in agri-environmental policy design. Within the European Union, for example, DCEs have informed the development of targeted agri-environmental schemes under the Common Agricultural Policy (Schulze et al., 2023). In developing countries, they have been used to evaluate smallholder preferences for climate-smart agriculture, aligning sustainability initiatives with on-the-ground factors (Pham et al., 2022; Schaafsma et al., 2019).

In the context of climate change, DCEs are instrumental in assessing farmers' willingness to adopt adaptive practices and technologies, supporting the scale-up of climate resilience strategies (Zabala et al., 2025). This method is also increasingly employed to evaluate preferences for risk management tools, such as weather-indexed insurance and other financial instruments, thereby linking behavioral insights with product innovation in agricultural finance (Čop and Njavro, 2022; Doherty et al., 2021).

Beyond policy and finance, DCEs are applied to assess farmer choices around input use, including cover cropping, pesticide reduction, and participation in carbon sequestration initiatives (Block et al., 2024; Nong et al., 2021). These insights are critical for designing interventions that align environmental goals with farmer incentives.

Recent applications also highlight the role of DCEs in understanding farmers' attitudes toward collective action and institutional coordination. This includes complex agri-environmental initiatives like peatland restoration and contiguous conservation efforts, where success depends on cooperation across landholders (Häfner and Piorr, 2021; Rocchi et al., 2017). Additionally, DCEs are being used to explore farmer engagement in circular economy models within the agri-food sector, offering valuable evidence for transitions toward sustainable production and consumption systems (Cahyadi et al., 2024; Guzzo et al., 2022).

Overall, the use of DCEs marks a shift toward more evidence-based, participatory, and farmer-centered approaches in agricultural policy and program design. This chapter reviews the methodological evolution and thematic applications of DCEs in agriculture, with a focus on how they illuminate the diverse and complex preferences that shape farming decisions in the face of environmental, economic, and institutional challenges.

Discrete choice experiments and farmers' preferences for animal welfare schemes

This section explores how discrete choice experiments (DCEs) are used to investigate farmers' preferences for animal welfare schemes, with a focus on both industrialized and developing contexts. DCEs are a well-established stated-preference method that allow researchers to quantify how farmers evaluate trade-offs between different features of animal welfare programs. This approach provides valuable insights into the relative importance of scheme attributes such as economic incentives, administrative burden, and flexibility and reveals the heterogeneity of preferences across individuals and production systems (Bock and Van Huik, 2007; Rocchi et al., 2017). These findings are critical for designing agri-environmental policies that are not only

economically viable but also aligned with farmers' operational constraints and ethical considerations (Balzani and Hanlon, 2020b).

While research on farmers' attitudes toward animal welfare and related policies is extensive in high-income countries, it remains underdeveloped in the context of low- and middle-income nations (Parlasca et al., 2023). This gap is especially concerning as intensive livestock production systems continue to expand globally, introducing new and context-specific animal welfare challenges that cannot be addressed by policy models developed solely in industrialized settings (Marchant et al., 2023).

In Germany, multiple DCE studies have shown that farmers' willingness to participate in animal welfare schemes is significantly influenced by financial compensation, perceived administrative burden, and the degree of institutional trust. For instance, German pig farmers consistently prefer programs that offer realistic remuneration and minimize regulatory complexity (Danne and Mußhoff, 2022). Similarly, Schröter and Mergenthaler (2021) found that farmers favored voluntary over mandatory participation, especially when schemes offered practical, farm-level applicability.

A broader comparative study by Latacz-Lohmann and Schreiner (2019) employed a standardized DCE design across several countries to examine both consumer and producer preferences for FAW. Their findings underscore the universal importance of scheme design elements such as contract duration, monitoring mechanisms, and restrictiveness in shaping farmers' decisions, regardless of national context.

In contrast, research from developing countries remains limited but is gradually emerging. In Kenya, a DCE investigating cattle farmers' preferences for disease-free zones which indirectly reflects animal health and welfare concerns found strong support for incentive-based programs that provided veterinary services and training through trusted local institutions (Otieno et al., 2011). In South Africa used a DCE to examine smallholder farmers' preferences for livestock vaccines. Their findings indicated that willingness to adopt welfare-enhancing practices was influenced by farm size, livestock type, and prior experiences with disease outbreaks, highlighting the importance of local context in program design (Masemola et al., 2021).

Together, these studies demonstrate the versatility of DCEs in uncovering both generalizable patterns and context-specific preferences. Such evidence is indispensable for tailoring animal welfare policies to diverse farming systems and ensuring higher rates of participation and compliance.

2.3. Human-Wildlife Conflict (HWC)

Human-wildlife conflict represents one of the most pressing conservation and livelihood challenges globally. As human populations expand and encroach on natural habitats, direct interactions between humans and wildlife have increased, often resulting in detrimental outcomes for both parties (Gemeda and Meles, 2018; Pettigrew et al., 2012; Yengoh, 2025). Globally, HWC leads to loss of biodiversity, threats to human safety, and economic damage, especially in communities that rely on agriculture and pastoralism for survival (Liu et al., 2024; Nyamwamu, 2016; Treves, 2007). According to the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), over 70% of the world's protected areas are adjacent to human settlements, making interaction with wildlife inevitable (Li et al., 2024).

Recent studies highlight that large carnivores such as lions (Panthera leo), leopards (Panthera pardus), and wolves (Canis lupus) are among the most conflict-prone species due to their predatory nature and extensive territorial needs (Braczkowski et al., 2023). The global trend toward the fragmentation of habitats exacerbates conflict risk by restricting wildlife movements and access to prey. In particular, communities with limited resources often lack the means to erect barriers or implement deterrent strategies, making them more vulnerable to wildlife attacks (Karsai et al., 2020).

Moreover, HWC is increasingly viewed through the lens of social justice. Braczkowski et al. (2023) underscore the "unequal burden" of wildlife conflict, arguing that rural communities in the Global South disproportionately bear its impacts due to weak institutions, limited access to compensation, and marginal political voice. As such, understanding HWC requires interdisciplinary approaches that combine ecological, socio-economic, and political perspectives.

Human and animal conflict in Africa

In Africa, HWC is particularly acute in countries where wildlife conservation is vital to national economies and cultural identity. Protected areas such as Kruger National Park in South Africa, Serengeti in Tanzania, and Chobe in Botswana serve as biodiversity hotspots but are also epicenters for conflict due to their proximity to rural communities (Gupta, 2013; Holmern, 2007; Scogings, 2004). The expansion of agriculture into wildlife habitats is a principal driver of these conflicts. In Tanzania, for example, elephants (Loxodonta africana) frequently raid crops, with some households reporting losses amounting to over 50% of their annual income (Kiffner et al., 2021; Mwakatobe et al., 2014).

A study emphasized the cyclical nature of HWC, were economic losses from crop and livestock damage lead to retaliatory killings of wildlife, thereby undermining conservation efforts (Kidane et al., 2024; Muriuki et al., 2017). Furthermore, institutional failures such as inadequate compensation schemes and exclusion of local voices in park management exacerbate tensions and foster resentment toward conservation initiatives (Gloriose, 2019; Zhou, 2023).

Efforts to mitigate conflict have increasingly focused on coexistence strategies. These include non-lethal deterrents, participatory governance models, and the integration of traditional ecological knowledge. Marker et al. (2021) documented the successful deployment of livestock-guarding dogs in Namibia, which reduced predation by cheetahs by over 80%. Similarly, community-based natural resource management initiatives in Zimbabwe and Namibia have shown promise in aligning conservation and livelihood goals (Marker and and Boast 2015).

Human-Wildlife Conflict in Ethiopia

In Ethiopia, the challenge of HWC is deeply intertwined with rural livelihoods, land use change, and conservation policy. Protected areas such as Bale Mountains National Park, Chebera Churchura, and Nech Sar National Park serve as critical wildlife refuges but are also hotspots for conflict due to surrounding pressures (Kelboro and Stellmacher, 2015; Yihune and Tsegaye, 2024). As observed by Deneke et al. (2022), livestock predation by hyenas, leopards, and jackals is a routine occurrence in buffer zones, often leading to retaliatory killings and friction between communities and park authorities.

The lack of clear demarcation and physical barriers in Nech Sar National Park has enabled unrestricted wildlife movement into nearby agricultural areas, leading to significant crop and livestock losses for local communities (Seid and Kakiso, 2019). This situation is exacerbated by top-down, state-driven conservation approaches that frequently neglect the livelihood needs and land-use practices of adjacent populations, resulting in persistent conflict and mistrust (Kelboro and Stellmacher, 2015). To address these tensions, scholars emphasize the importance of integrating traditional ecological knowledge into formal conservation planning, fostering collaboration between park authorities and local communities (Debelo, 2012).

Gender in human-wildlife conflict

Gender dimensions of human-wildlife conflict are increasingly recognized in both academic research and policymaking. In rural African contexts, men and women interact with the environment in distinct ways shaped by their social roles, labor responsibilities, and access to

resources. Studies show that men are typically responsible for managing large livestock like cattle and engaging in herding activities, while women primarily care for poultry, perform household duties, and engage in subsistence farming. These gendered roles lead to different exposures and vulnerabilities to wildlife conflict and must be considered in conservation and livelihood planning(Coyle et al., 2020; Njuki and Sanginga, 2013; Omed and Majale, 2022).

Research shows that although male-headed households often suffer greater absolute losses from livestock predation due to owning larger herds, the relative economic impact on female-headed households is frequently more severe. This disparity stems from limited access to credit, insurance, and recovery programs, as well as exclusion from key decision-making platforms in conservation planning (Yeshey et al., 2023), Women may lack access to insurance, credit, or recovery programs, and face barriers to participating in decision-making spaces concerning conservation (Asiseh et al., 2024)

Mainstreaming gender into conservation planning has been shown to significantly enhance the effectiveness of human-wildlife conflict (HWC) management and improve household resilience. Participatory initiatives that empower women such as community-based conservation efforts and local governance structures like agro-ecological zoning committees are associated with increased conservation success and community well-being. For instance, studies in Tanzania found that women involved in community-based conservation felt more empowered economically and socially, contributing to better conservation outcomes (Krietzman, 2019). Additionally, regional strategies for gender mainstreaming in conservation, such as those developed in REDD+ processes across 17 African countries, emphasize women's active participation in policy-making as critical to sustainability and equity (Nairesiae et al., 2019).

Traditional guarding and animal friendly housing in livestock protection

Traditional guarding practices, such as night herding, the use of guard dogs, thorn fencing, and fire are widely used in rural African communities. These techniques are cost-effective and culturally grounded but vary in effectiveness depending on the predator and context. Studies confirm that integrating traditional methods with modern tools like motion-activated lights, predator-proof corrals, and fladry can significantly reduce livestock losses. For example, combining guarding dogs with improved fencing or lighting solutions has shown up to 91% success in preventing livestock depredation (Potgieter et al., 2016; Wanjira et al., 2021). In resource limited settings, such hybrid approaches that blend traditional knowledge with low-cost modern innovations are especially promising.

A recent study in Mongolia tested reinforced fencing structures and found they were highly effective in reducing night-time predation at livestock corrals. Self-reported livestock losses dropped from an average of 3.9 animals per family per winter to zero over two winters after implementing tall fences (Samelius et al., 2021). However, such measures require upfront investment and community buy-in, both of which are often lacking in rural Ethiopia.

Improved livestock housing, particularly predator-proof enclosures, has been shown to be an effective strategy for reducing predation and human-wildlife conflict. In Kenya, the implementation of subsidized predator-proof bomas reduced livestock losses by up to 85%, with significant improvements in community security and livestock survival (David, 2014b). These shelters also help reduce grazing pressure on protected lands and limit disease transmission between wildlife and livestock (Mizutani et al., 2005).

Economic constraints in Ethiopia present a major barrier to the widespread adoption of predator-proof livestock housing. However, evidence suggests that farmers are willing to adopt environmentally friendly livestock housing if they receive financial support. This aligns with findings showing that adoption of conservation measures increases when subsidies are framed as participatory initiatives rather than imposed mandates (Belay et al., 2020). Moreover, improved livestock shelters not only reduce conflict by preventing predation but also contribute to environmental sustainability by lessening overgrazing, reducing soil erosion, and limiting water contamination (Challa, 2021).

Chapter 3: Methodological Framework

This chapter presents the methodological framework guiding the three empirical studies constituting this dissertation. Each study was designed to explore a distinct but interconnected dimension of livestock management in Ethiopia: farmers' willingness to adopt animal welfare schemes, the conditions affecting animal welfare in livestock markets, and the socio-economic impacts of human–wildlife conflict near protected conservation.

3.1. Method of data collection (Study1)

Study location and sampling procedure

The study site Dugda – is district in central Ethiopia (***Appendix A***). The district has a total area of 923.7 km² and encompasses landscapes with different altitudes and arid, semi-arid, and sub-humid agroecology zones. Dugda had an estimated total population of 227,064 of which 51.2% are female. Semi-subsistence crop-livestock mixed farming is the mainstay of livelihood where the key objective of the households is producing food for the family (CSA, 2022).

Dugda was selected purposively for our study due to its previous engagement in community conversations about fundamental aspects of animal welfare, including health, nutrition, environmental conditions, behavior and mental/emotional well-being. The community conversations were facilitated by the "Synergies of Animal Welfare and Agroforestry" (SAWA) project in five kebeles [the smallest unit of administration]. SAWA selected Dugda for its potential in agroforestry farming, which aligns with the project's goal of exploring the intersections between animal welfare and agroforestry practices (Alemayehu et al., 2022a). Dugda's diverse Agro-climatic zones make it an ideal setting to examine the influence of environmental factors on farming practices and animal welfare.

Due to financial and time constraints, our survey could not cover all 22 kebeles. Instead, we randomly selected three kebeles out of the five kebeles that were part of the SAWA project.

Data collection and survey

Before conducting the main survey, all necessary ethical approvals were obtained, including informed consent, confidentiality, and participants' right to withdraw. International guidelines were followed to ensure transparency and protection of participants, and research permissions were obtained (permission from regional officials; consent from local authorities within the district according to local and international standards). We implemented the survey in two steps. The first

step gathered comprehensive data on the sociodemographic characteristics of the participating households. Additionally, we explored their attitudes and perceptions toward various aspects of animal care and management.

The second step elicited preferences for different characteristics of animal welfare practices using DCE. We started with a pilot survey of 10 respondents to evaluate the logical flow, clarity, and effectiveness of the instrument. After that we conducted a DCE using a structured questionnaire. From January to mid-February 2022, a structured survey was conducted through in-person interviews with 100 smallholder farmers. Households were selected using systematic random sampling from official resident lists provided by the respective kebele administrations, which served as the sampling frame. These lists included all registered farming households within each kebele. Enumerators, trained in advance on the study protocol, used these lists to select every third household for inclusion. The starting point in each kebele was randomly chosen, after which enumerators proceeded along accessible roads or footpaths according to a predefined path developed during field planning, ensuring geographic coverage while maintaining the sampling interval. All interviews were conducted at the farmers' homes to maximize comfort and ensure respondent availability. Each participant completed 12 discrete choice sets, resulting in a total of 1,200 observations (12 sets × 100 respondents). The aim was to understand the factors influencing farmers' decisions to participate in voluntary animal welfare schemes, focusing on household heads to gain insights into their decision-making processes.

A cheap talk script was read for the respondents before the actual survey to mitigate hypothetical bias, thereby enhancing the validity of the findings by addressing potential discrepancies between what respondents claim they would do in a hypothetical scenario and their actions in real life (Andor et al., 2017).

The enumerators chosen to conduct the survey were individuals familiar with the local context, proficient in the local language, and with previous experience in similar surveys. The enumerators received comprehensive training on the technical aspects of the study and were instructed on the ethical standards that govern choice experiments.

Selection of Choice Attributes and Levels

The identification of attributes and their corresponding levels plays a pivotal role in the design of DCEs for the effective elicitation of preferences (Scarpa and Rose, 2008). Following the pilot survey, we consulted animal science researchers and veterinarians to refine our approach for the main survey. We then held a three-day preliminary discussion with farmers from three selected

kebeles. During these discussions, farmers elaborated and gave detailed descriptions of the chosen attributes. We summarized the descriptions and presented them to farmers to ensure full comprehension.

Given the challenge of encompassing the full spectrum of animal welfare, our study focused on those attributes considered critical, drawing upon the 'five freedoms' framework as a guide for characterizing animal welfare (McCulloch, 2013). A detailed enumeration of animal welfare attributes and their levels is presented in Table 1.

Table 1: Attributes of animal welfare schemes included in the DCE.

Attribute	Description	Levels
Animal Welfare Standards	Clear, incremental improvements in animal welfare.	Basic Enhanced Optimal
Financial incentives	Reflects a scalable instrument to motivate participation without binding to fixed monetary values.	5% livestock sales/year 10% livestock sales/year 15% livestock l sales/year 20% livestock sales/year
Training and Support	The degree and type of training and support provided to participants for implementing and maintaining animal welfare practices.	Basic training (e.g., annual workshops) Enhanced training (e.g., quarterly workshops, ongoing support)
Certification and Recognition	The form of acknowledgement participants receives for their involvement highlights the social and reputational benefits of participation.	Certificate of Participation Public acknowledgement (e.g., in the local media)
Contract Duration	The commitment duration required from participants - indicating the intended long-term involvement and stability.	1 year 2 years 3 years 4 years
Community Involvement	The level of community engagement and collective decision-making within the scheme - showcasing the inclusivity and participatory approach to animal welfare.	Individual-based decisions Community-based decisions

Source: Author own work

Animal welfare standards are critically important in determining farmers' willingness to engage with animal welfare schemes. Kassie et al. (2022) highlights the importance of considering farmers' preferences and behaviors in the design of livestock management initiatives. This insight underscores the need for animal welfare schemes to balance the animal welfare requirements with participants' capacities and preferences. Well-structured animal welfare standards that are achievable and aligned with farmers' operational ability can foster better adherence to welfare practices, ensuring the effectiveness and sustainability of the scheme. Therefore, basic welfare ensures the animals have access to essential needs such as food, water and minimal shelter aims to

prevent severe forms of neglect and suffering (Mellor and Stafford 2001; Grandin 2019). Enhanced welfare builds up the basic requirements by improving living conditions, including better shelter and more space for movement. The study by David (2014) indicated that better housing and environmental enrichment are critical to reducing stress and improving overall health. Optimal welfare encompasses the highest level of care including comprehensive veterinary care and taking a holistic approach, considering both the physical and psychological well-being of animals (Fraser, 2008; Mellor, 2015)

Financial incentives are crucial in influencing participation in voluntary schemes. The percentage-based incentive is designed to reward farmers for their commitment to improving animal welfare, with higher percentages for higher levels of commitment or achievement. Reed et al. (2014) explore spatially targeted outcome-based payments as potentially more economically efficient than traditional methods. This approach, which involves percentage-based incentives, addresses the challenges in market price fluctuation, the timing of payments, and location-specific constraints. The study emphasizes the role of innovative payment modalities, including percentage-based incentives, to improve the link between payments and the actual provision of ecosystem services. Ola et al. (2019) highlight the importance of providing sufficient payments for ecosystem service (PES) providers to enhance PES program performance. The study underscores the need for payment incentives that cover costs and address location-specific constraints, suggesting that adaptable incentive structures, such as percentage-based incentives, can be crucial for tailoring PES programs to specific ecological and economic contexts.

Training and support are critical attributes for ensuring the successful implementation of animal welfare practices. A study on nonfinancial incentives for health extension workers in Ethiopia by Oladeji et al. (2022) provides insights into how training and career advancement opportunities can significantly impact retention and commitment. This study indicated that opportunities for continued education and supportive management are highly valued, which could be translated into the animal welfare context as a preference for schemes that offer comprehensive training and ongoing support for participants. Enhanced training and support not only facilitate better adoption of welfare practices but also contribute to the sustainability of such initiatives by building local capacity and ensuring that participants are well-equipped to meet compliance requirements (Oladeji et al., 2022).

Certification and Recognition for taking part in voluntary schemes can provide social and reputational benefits that may motivate individuals to join and adhere to the program standards.

The concept of public recognition as an incentive aligns with the findings of Tarfasa and Brouwer (2018) who explored public preferences for improvements in solid waste services in Ethiopia. Their study highlights how social recognition and willingness to pay for environmental services are influenced by social benefits, including the value placed on child labor abolishment and gender-specific preferences. Applying these insights to animal welfare suggests that recognition, either through certificates or public acknowledgement, could enhance participants' social standing and contribute to broader societal appreciation for sustainable practices (Tarfasa and Brouwer, 2018).

Contract duration defines the length of commitment required from participants, measured in set intervals (1, 2, 3 and 4 years). Discrete durations provide stability, facilitate program monitoring, and align with agricultural cycles, making it easier for participants to plan and commit to the program's animal welfare practices. This alignment allows participants to plan around critical farming periods, enhancing commitment and reducing potential disruptions to income or resource allocation (FAO, 2021).

Community involvement in the planning and execution of voluntary animal welfare schemes significantly enhances their success and acceptance by fostering a sense of ownership and responsibility. The study by Cecchi and Bulte (2013) highlights how people with market experience, such as sesame farmers and brokers in rural Ethiopia, tend to make more logical and informed decisions. This behavior results from engaging in competitive markets where decisions must be made with a clear understanding of the outcomes. Applying these principles to animal welfare schemes means that incorporating insights from community members with market experience can lead to more sustainable and effective programs.

Experimental Design and Choice Tasks

The DCE tool R package developed by Pérez-Troncoso (2022) was used to generate the experimental design for this study. Each farmer was presented with twelve distinct choice sets during the final phase of the experiment. Considering the complexity of the choice task, the decision to present 12 choice situations was assessed as manageable for the participants (Bech et al., 2011; Lancsar and Louviere, 2008). A sample of the choice sets is presented in Table 2.

In both the pilot study and the final experiment, each choice set contained three alternatives: two hypothetical animal welfare schemes and an optout option. The incorporation of an opt out option is necessary as it guarantees that respondents would not be compelled to choose an animal welfare package if their preference was to uphold the status quo or were not interested in either of the

hypothetical welfare schemes. This strategy helps avoid the pitfalls associated with forced choices, which could introduce inaccuracies and inconsistencies that conflict with established demand theory, as discussed by Hanley, Mourato, and Wright (2001).

Table 2:Sample choice set of animal welfare scheme.

Attributes	Animal welfare scheme A	Animal Welfare Scheme B	No animal welfare package
Animal Welfare Standards	Basic	Enhanced	Unchanged housing conditions and no bonus payments
Financial incentives	5% livestock sales/year	15% total livestock sales/year	
Training and Support	Basic training	Enhanced training	
Certification and Recognition	Certificate participation	Public acknowledgement	
Contract duration	4 years	1 year	
Community Involvement	Individual-based	Community-based	
Which alternative do you choose?	O	O	O

Source: Author own work

3.2. Method of data collection (study 2)

Description of study area and survey

This study involved a combination of methods, including a survey distributed to market actors, live observations, and video recordings of goat and sheep trading activities. A pilot study was conducted at the Adama (secondary market type) and Addis Ababa (terminal market type) to refine the survey and to select appropriate market locations. For the main data collection, three livestock markets were selected from Meki (local market), Adama (secondary market) and Addis abeba (terminal market) based on their significance in terms of the species and number of animals traded as well as the frequency of the market, i.e. whether they take place daily or weekly.

For each observed sheep and goat transaction, data were collected through structured surveys and direct observations, including information on the number of animals sold and their body condition. Body condition grading was adapted from exiting literature (Vall et al., 2025; Vieira et al., 2015) as described in table 1. The body condition was graded in three categories (Thin, Normal and Fat) using visual observation, which is the grading method most frequently utilized by market actors in the study areas.

Table 3:Body condition scoring based on visual assessment in small ruminants.

Body condition	Description	Physical indicators
Thin	animals exhibit poor body condition, lack muscle and fat reserve	- ribs, spine, and hip bones are very prominent and easily visible in goats and shorn sheep - no fat cover on the sternum or loin area. - animal may appear angular with poor muscle mass.
Normal	animals have a healthy balance of muscle and fat	-spine and ribs are covered with a slight fat layer, smooth to touch but still palpable. - hip bones are not sharp and there is gentle rounding of the loin. - moderate fat cover over the sternum.
Fat	animals have excess fat reserves.	- ribs and spine are difficult or impossible to feel due to thick fat cover. - back appears flat or rounded due to fat deposits. -fat accumulation around the tail head, brisket and sternum.

A total of 100 market actors (farmers, traders, suppliers and others) were randomly selected from three markets: Addis Abeba (n = 50), Adama (n = 25), and Meki (n = 25). Interviews were conducted with the individuals responsible for the animals at these markets. Both male and female market participants were included in the sample to allow for analysis of gender effects.

To assess the adoption of humane animal handling practices among market actors, participants were asked to select the one that best describes handling the typically used from a list of four commonly observed practices. The listed practices were explained during data collection using practical terms familiar to the market actors

1. Using loud noises or shouting to move animals.
2. Applying low-stress handling techniques.
3. Keeping animals separated.
4. Moving animals as quickly as possible regardless of conditions

To assess market actors' practices for loading animals into transport vehicles, respondents were asked a set of four response options to select the one that best describes their handling practices:

1. Using force and pressure to load animals quickly.
2. Ensuring animals are loaded calmly and with care to avoid stress.
3. Loading animals without any pre-transport rest.

4. Loading animals in mixed groups unfamiliar with each other

Respondents were asked to indicate their unloading practices with a set of four response options to select the one that best describes their handling practices:

Quickly minimize transport costs.

Calmly and carefully, allowing animals to adjust to their new surroundings.

Without providing water or rest immediately after unloading.

Unloading regardless of animal stress

The decisions on the sample of interviewees during the study were influenced by the information available, the time and resources available, the accessibility and openness of the market participants, as well as the estimated size of the trading population (Mendoza, 1995).

Additionally, we video-recorded group of sheep and goats at the markets (two videos per market of 3 – 4 minutes, each) to assess the general welfare of the animals in the markets, using the "Five Freedoms" framework (Mellor, 2016) as a basis for scoring and evaluating the welfare levels of the animals. This assessment was conducted using table 2, which outlines a quantitative evaluation method based on visual indicators. welfare indicators such as feed and water access, shelter availability, injury, social interaction and behavioural signs of stress were scored on a 1–3 scale, with higher scores indicating better welfare conditions. This scoring system enabled comparison between groups of animals using only observable behaviours and environmental cues from video footage. The method follows established welfare assessment practices and has been validated based on the existing research involving visual-only welfare indicators for sheep and goats (Diaz-Lundahl et al., 2019; Llonch et al., 2015; Phythian et al., 2013).

Table 4: Animal welfare assessment based on visual indicators aligned with each of the Five Freedoms.

Five Freedom framework	Indicator	Score 1 (Poor)	Score 2 (Moderate)	Score 3 (Good)	Explanation/ observations
Freedom from Hunger and Thirst	Accessibility of Water and Feed	No feed/water; animals struggle to access.	Limited access: some animals compete for resources.	Easy access to sufficient feed/water for all animals.	Is water/feed present and accessible to all animals?
	Behavioral Signs of Hunger/Thirst	Many animals are visibly	Few animals showing mild signs of	No visible signs of	Are animals visibly

Five Freedom framework	Indicator	Score 1 (Poor)	Score 2 (Moderate)	Score 3 (Good)	Explanation/ observations
		hungry or thirsty.	hunger or thirst.	hunger or thirst.	hungry or thirsty?
Freedom from Discomfort	Availability of Shelter or Shade	No shelter/shade; animals exposed to weather.	Limited shelter/shade; some protection but not enough for all.	Ample shelter/shade available for all animals.	Are animals protected from extreme weather (heat/rain)?
	Adequate Space for Resting	No space: animals are overcrowded and cramped.	Limited space: some animals struggle to rest comfortably.	Adequate space for all animals to rest comfortably.	Do animals have enough space to rest comfortably?
Freedom from Pain, Injury or Disease	Visible Injuries or Signs of Illness	Many animals are visibly injured or ill.	Few animals with minor injuries or signs of illness.	No visible injuries or signs of illness.	Are there visible signs of pain, injury, or disease?
	Health and Physical Condition	Many animals appear weak or malnourished.	Most animals appear healthy, but a few shows minor issues.	All animals appear healthy and in good physical condition.	Are animals healthy, active, and free from disease?
Freedom to Express Normal Behavior	Ability to Move Freely	Animals are restrained or overcrowded; no freedom to move.	Limited freedom to move; some animals can move.	Animals can move freely without restrictions.	Can animals move freely, without restraints?
	Social Interaction	Animals are isolated; no opportunity to interact.	Limited interaction due to space or restraints.	Animals interact naturally and socialize freely.	Can animals interact with others naturally?
Freedom from Fear and Distress	Behavioral Indicators of Fear/Distress	Many animals show fear/distress (e.g., vocalizing, trembling).	Some animals show mild signs of fear/distress.	No visible fear/distress; animals appear calm and relaxed.	Are animals showing fear, distress, or aggression?

Five Freedom framework	Indicator	Score 1 (Poor)	Score 2 (Moderate)	Score 3 (Good)	Explanation/ observations
	Market Environment (Noise, Chaos)	Very noisy and chaotic, causing severe stress.	Moderately noisy/chaotic; some stress observed.	A quiet, organized environment with no distress caused.	Is the environment quiet, organized, and non-stressful?

The table outlines criteria for evaluating animal welfare across five freedoms: freedom from hunger and thirst, discomfort, pain/injury/disease, freedom to express normal behaviour, and fear/distress using observable indicators. Each criterion is scored on a 1–3 scale: 1 (poor), 2 (moderate), and 3 (good) based on visual signs and environmental conditions.

3.3. Method of data collection (Study 3)

Description of the study area

The present study was conducted in the Nech Sar National Park of Ethiopia (Appendix B). Nech Sar National Park holds immense importance for Ethiopia, both from an ecological and cultural perspective. As one of the country's premier wildlife sanctuaries, the park plays a crucial role in conserving Ethiopia's unique biodiversity and in preserving endangered species. With its diverse landscapes, ranging from grassy plains to lush woodlands, and its two prominent lakes, Lake Abaya and Lake Chamo, the park provides a habitat for a plethora of animal and plant species (Nech-Sar national parl, 2023). The preservation of such rich flora and fauna is vital to maintaining the delicate balance of ecosystems and ensuring the continued survival of these species.

Nech Sar National Park is a crucial ecological and cultural asset in Ethiopia, supporting biodiversity, preserving local traditions, and promoting sustainable ecotourism that benefits both conservation and the local economy (Ahmedin, 2020; UNEP-WCMC, 2023). Its protection ensures the survival of endangered species, fosters scientific research, and exemplifies Ethiopia’s commitment to environmental stewardship and sustainable development.

Survey

A survey was developed to gather information on human-wildlife conflicts and how people respond to them. To ensure the questions were clear and relevant, a pre-test was conducted with 3 elders from each of the three selected kebeles (which are the smallest administrative units) (resulting in 9 participants in total). These elderly people, who hold traditional leadership roles were selected for their experience with local issues, including human-wildlife conflicts. Their feedback helped refine the questions before finalizing the survey for wider distribution.

The final interviews were conducted across four study kebeles. The distances between the kebeles and Nech Sar National Park were measured from the approximate center of each kebele to the boundary of the park. This method of measurement was chosen as it provides a standardized way to assess proximity, which is relevant for understanding the potential influence of distance on human-wildlife conflict. The kebeles and distances were: Shecha (16 km), Genita Kenchima (21 km), Chano Doriga (23 km), and Shelle Mele (26 km).

The final survey was then conducted among a total of 100 respondents, consisting of 75 randomly selected participants and 25 key informants. The key informants, a mix of local leaders, wildlife officers, and local government officials, were chosen through consultation with community leaders. Respondents for the survey were randomly selected around the area of Nech-Sar national park through a lottery system based on their house identification numbers. The survey aimed to identify and quantify livestock losses due to predation, assess respondents' knowledge of predation trends, and understand their attitudes towards problematic wildlife. It also gathered information on crop damage caused by wildlife, the methods used by locals to protect livestock, and the distance between respondents' homes and Nech Sar National Park. The survey also explored traditional guarding methods and respondents' views on government regulations and whether they had received compensation or training for wildlife-related losses. The full survey is available upon request.

The survey consisted of 30 questions, divided into two sections: 5 demographic questions (age, gender, literacy, marital status, and occupation) and 25 questions on livestock predation, crop damage, and attitudes toward wildlife. On average, it took 20 to 30 minutes to complete. The survey was conducted through live interviews by a team of 4 trained interviewers ensuring clarity and consistency. It was administered in Amharic and Gamo (local language) to accommodate language preferences.

3.4 Method of data analysis (study 1)

Analytical Framework

Animal welfare schemes can be considered as quality differentiated services. Quality differentiation in this case implies that the schemes can be fully described as a set of characteristics. These characteristics are the means with which the consumers (or users) of the service derive satisfaction. Economic analysis of the behavior of consumers of quality differentiated goods is done based on Lancaster's characteristics theory of value (Lancaster, 1966). Lancaster has established that goods and services are consumed not simply because they are goods and services

per se. Rather, they are consumed because of their intrinsic attributes that consumers are looking for in the goods and services. Therefore, the value consumers attach to a quality differentiated good is the sum of the values of the intrinsic characteristics considered by the consumers in choosing the good.

In our case, the welfare schemes will have a definite set of characteristics that are going to define the choices farmers are to make among different hypothetical options. As discussed above, the characteristics of animal welfare schemes we are evaluating are only the most important attributes for livestock keepers in the study area. Yet, there are other characteristics not considered in the study for practical reasons. In addition to the inability to consider all characteristics, the choices made by consumers are explained by observed and unobserved factors. The unobservable factors introduce randomness in the choice decision analysis. McFadden's random utility theory (RUT) (McFadden, 1973) enables us to divide the perceived utility - that is behind choosing a scheme out of a set of them – into deterministic and random components.

RUT postulates that respondents' choices can be modelled as a function of the characteristics of the alternatives considered and a random or unexplained component. Therefore, the utility (U_{ij}) that farmer i derives from choosing alternative j is modeled as:

$$U_{ijt} = V_{ijt} + \epsilon_{ijt}$$

where V_{ij} represents the deterministic component of utility, and ϵ_{ij} captures the unobserved, random component of utility.

Given the attributes in the DCE, i.e., animal welfare standards (AWS), financial incentives (FI), training (TS), certification and recognition (CR), contract duration (CD), and community involvement (CI), the utility function can be specified by expanding the deterministic component as:

$$U_{ijt} = \beta_0 + \beta_{AWS\_Enhanced} * AWS\_Enhanced_{ijt} + \beta_{AWS\_Optimal} * AWS\_Optimal_{ijt} + \beta_{FI\_10} * FI\_10_{ijt} + \beta_{FI\_15} * FI\_15_{ijt} + \beta_{FI\_20} * FI\_20_{ijt} + \beta_{TS\_Enhancedtraing} * TS\_Enhancedtraining_{ijt} + \beta_{CR\_Public} * CR\_Public_{ijt} + \beta_{CD\_2} * CD\_2_{ijt} + \beta_{CD\_3} * CD\_3_{ijt} + \beta_{CD\_4} * CD\_4_{ijt} + \beta_{CI\_Community} * CI\_Community_{ijt} + \varepsilon_{ijt} \ldots\ldots\ldots\ldots Equation\ 1$$

Where:

β_0 is the intercept term representing the base utility level.

$\beta_{AWS\_Enhanced}$ and $\beta_{AWS\_Optimal}$ are coefficients for the levels of animal welfare standards, with basic as the reference category.

β_{FI_10} , β_{FI_15} and β_{FI_20} are coefficient for different levels of financial incentives, with 5% of total sales (FI_5) as the reference category.

$\beta_{TS\_Enhancedtraing}$ is coefficient for enhanced training, with basic training as the reference category.

β_{CR_Public} : is coefficient for public acknowledgement, with a certificate of participation as the reference category.

β_{CD_2}, β_{CD_3} and β_{CD_4} are coefficients for different contract durations, with 1 year as the reference category.

$\beta_{CI\_Community}$ is coefficient for community-based decisions, with individual-based decisions as the reference category.

ε_{ijt} is the random error term that captures unobserved factors affecting the utility.

Assuming the random component of the utility to be distributed independently and identically (iid) extreme type I, the probability (P), conditional on the vector of the coefficients (β_n), that the farmer chooses animal welfare scheme j out of m alternatives in a choice set t is a conditional logit (McFadden, 1973):

$$P_{njt}(\beta_n) = \frac{e^{X'_{njt}\beta_n}}{\sum_{l=1}^{m} e^{X'_{nlt}\beta_n}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad \textit{Equation 2}$$

The conditional logit assumes homogeneous preferences for the different characteristics of the welfare schemes across all respondents and the taste parameters of each respondent (β_n) are known and completely explained by the estimated means only.

It is however sufficiently proven that individual consumers have heterogeneous preferences for characteristics of goods and services (Kassie et al., 2017; Ouma et al., 2007). Therefore, we estimated a mixed (or random parameters) logit model that relaxes this limitation of conditional logit model in addition to its increased flexibility. In the mixed logit model (MXL), the β_n values are specified to be random, and we assumed all coefficients to be normally distributed.

The random taste parameters, β_n, are unobserved and so the unconditional probability that a farmer will choose alterative j is estimated by integrating the conditional probabilities over all value of each of the random taste coefficients weighted by its density function (Train, 2009). Hence:

$$P_{njt} = Pr(Y_{nt} = j) = \int \frac{e^{X'_{njt}\beta_n}}{\sum_{l=1}^{m} e^{X'_{nlt}\beta_n}} \phi(\beta_n|\beta, \Sigma_\beta) d\beta_n \ldots\ldots\ldots\ldots\ldots\ldots \quad \textit{Equation 3}$$

where the integral is multidimensional and $\phi(\beta_n|\beta, \Sigma_\beta)$ is the multivariate normal density for β_n with mean β and variance Σ_β. Simulated maximum likelihood method is then used to estimate these unconditional choice probabilities (Train, 2009).

Estimating marginal willingness to accept

WTA measures for attributes correspond to average compensatory payments that farmers would accept to improve the attribute level by one unit (or adopt a new category of an attribute) when the value is negative and give up when the value is positive. WTA measures for attributes are a convenient method to compare the marginal utility values that respondents assign to the attributes. Estimation in either the WTA or preference space was used to calculate WTA measures. In the first case, the distribution of coefficients of the utility function is specified and a WTA distribution is then derived. This study follows the standard approach which assumes that attribute coefficients are normally distributed, and the payment coefficient is fixed to compute the WTA as the ratio of the coefficients for non-payment attributes (β_{kij}) to the negative of the payment attribute coefficient (β_{price}), such that:

$$WTA_{kij} = \frac{\beta_{kij}}{-\beta_{price}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad \textit{Equation 4}$$

The main problem with fixing the distribution of the payment coefficient while estimating the WTA in the preference space is that all individuals are assumed to have the same marginal utility of income (Meijer and Rouwendal, 2006), and variation in scale would be erroneously translated into variation in WTA resulting in untenably large WTA measures (Train and Weeks, 2005). To solve the problem of artifact measures, Train and Weeks (2005) recommend computing reasonable WTA estimates directly in the WTA space as presented in below Equation. Accordingly, we applied maximum simulated likelihood after reformulating the model in such a way that the distributional assumptions are made directly on the WTA measures.

$$U_{ijt} = \lambda_i(-P_{ijt} + \gamma_i x_{ijt}) + \epsilon_{ijt} \ldots\ldots\ldots\ldots\ldots\ldots \quad \textit{Equation 5}$$

P_{ijt} is the payment attribute, x_{ijt} is non-payment attributes, $\lambda_i = \beta_{P_i}/\sigma_i$, $\gamma_i = c_i/\lambda_i$, $c_i = \beta_{A_i}/\sigma_i$ and ϵ_{ijt} is the disturbance term distributed with variance given by $\sigma_i^2 = (\frac{\Pi^2}{6})$. σ is scale of the idiosyncratic error heterogeneity. β_A is a vector of parameter estimates of non-payment attributes to be estimated on WTA space.

3.5. Method of data analysis (study 2)

Analytical framework

The data was organized and analyzed using the STATA software. Descriptive statistics were computed to summarize demographics and transport impact on animals' condition. Logistic

regression analysis was performed to assess the association between transporter characteristics and the likelihood of reporting stress or discomfort in animals during transport. The presence of animal stress or discomfort during transport was assessed based on self-reports provided by livestock traders. Predictor variables included gender, years of experience, transport duration (in hours), and the number of sheep and goats transported. Marginal effects and predictive margins were computed and visualized to interpret the impact of transport duration and gender on stress likelihood. All statistical tests were two-tailed, and significance was determined at the $p < 0.05$ level. Additionally, Chi-square tests were conducted to examine whether the distribution of actors in the market significantly differs by gender across the three market types.

We tabulated the frequency of each humane handling practice, loading and unloading practices as determined by the survey within each market type and expressed these as column percentages so that each column sums to 100 %, thereby facilitating comparison across unequal sample size. A Chi-square test of independence (χ^2 test) was applied to evaluate whether significant differences existed in the distribution of reported practices across the three market types.

To assess the factors influencing the number of animals marketed, we employed a Poisson regression model appropriate for modelling count data to estimate incidence rate ratios (IRRs) for each predictor, with 95% confidence intervals. Model fit was assessed via the log-likelihood, and overdispersion was evaluated by comparing the residual deviance to the degrees of freedom. Standard errors were reported in parentheses alongside coefficient estimates, and statistical significance was determined at the $\alpha = 0.05$ level (two-tailed).

The final scores for the welfare assessment based on the Five-Freedom-assessment was averaged for each market across domains to yield a comparative welfare profile.

3.6. Method of data analysis (study 3)

Analytical framework

Descriptive statistics including proportions, means, and standard deviations, were computed to summarize the dataset. The monetary loss experienced by each respondent due to livestock predation by wild predators was calculated based on animals' selling price at the time of data collection. This data considers the variability in pricing, which depends on the buyers and the market conditions, as these prices are not fixed but fluctuate accordingly. These monetary values were then converted to USD to standardize comparisons across different livestock types and to ease interpretability.

To examine relationships between demographic variables and the number of livestock species lost to predation, as well as the prevalence of human-wildlife conflicts across the study area, a Chi-square test was employed. This test was also used to assess gender differences in responses regarding the willingness to adopt economically incentivized animal friendly housing. An Analysis of Variance (ANOVA) was used to analyze variations in monetary losses in relation to the distance from the Nech-Sar National Park boundary and to explore gender differences in livestock predation rates and the associated monetary losses.

[1]Chapter 4: Farmer preferences for animal welfare schemes (Study 1)

This chapter presents the findings from the discrete choice experiment study, which aimed to investigate smallholder farmers' preferences for voluntary animal welfare schemes. The chapter provides a detailed overview of the main results with a discussion of the implications of these findings for the design and implementation of animal welfare schemes.

4.1. Results and discussion

Descriptive statistics

The descriptive statistics indicate that most of the household heads are male (70%), with an average age of 39.20 years, ranging from 19 to 72 years. In terms of education, 72% of respondents have attended formal education, while the remaining have attended only informal [religious] education. The main source of livelihood for most households is farming (75%), with only 25% relying on other sources of income. Regarding livestock ownership, the average Tropical Livestock Unit (TLU) is a standard measurement for comparing livestock types based on feed needs, useful in tropical regions for assessing the overall livestock numbers and their potential environmental impact, owned by a household is 8.30 (Std. Dev. of 6.11). The number of small ruminants owned per household was on average 1.34 (Std. Dev. of 1.35). Financially, households earn an average income of 5478.95 birr[2] from livestock sales, with a high standard deviation of 6425.58. Additionally, income from livestock products' sales averages 1707.83 birr, with a standard deviation of 1151.90. The farmland owned by the surveyed households is on average 1.20 hectares, ranging from 0.13 to 8 hectares. The distance to the market, the veterinary services and the closest agricultural extension service average 47.35, 78.33 and 45.65 walking minutes, respectively (Table 3).

Table 5: Socio-economic characteristics of sample HH.

Variable		Frequency/Mean	Std. Dev.	Min	Max
Gender of HH	Male	70			
	Female	30			
Age of the HH (years)		39.20	11.67	19	72
Education Level	Non-formal Edu.	28			
	Formal Edu.	72			
	Farming	75			

[1] The first study investigates farmers' preferences and willingness to accept animal welfare initiatives; this paper has been submitted and is currently under revision at the *Journal of Agribusiness in Developing and Emerging Economies*.

[2] 1 USD =53.57 Birr in 2022.

Variable		Frequency/Mean	Std. Dev.	Min	Max
The mainstay of HH's livelihood	Other sources of income	25			
Livestock owned by HH (TLU)		8.30	6.11	0.36	24.55
Small ruminants owned by HH (TLU)		1.34	1.35	0.26	8.90
Income from livestock sale (birr)		5478.95	6425.58	600	30000
Income from livestock products' sale(birr)		1707.83	1151.90	0	5000
Land owned(ha)		1.20	1.36	.13	8
Distance to market (walking minutes)		47.35	52.13	2	150
Distance to Veterinary services (walking minutes)		78.33	53.12	0	180
Distance to the nearest agricultural extension (walking minutes)		45.65	53.21	2	180

Source: Author own work

The relative importance of the attributes

The mixed logit estimated in preference space resulted in a significant coefficient for the opt-out alternative suggesting that farmers value flexibility in their commitments to welfare schemes, possibly due to concerns over future uncertainties. This is further supported by farmers' generally low willingness to accept values for longer contract durations, as demonstrated by the negative coefficient for the three-year contract duration. Studies by (Train, 2009) and (McFadden and Train, 2000) suggest that when the opt-out coefficient is significant, it implies systematic differences in preferences not accounted for by observed attributes. In agricultural studies, these differences are often due to unquantifiable concerns like future market or policy uncertainties, underscoring the relevance of flexibility in farmers' choices (Greiner and Gregg, 2011; Ruto and Garrod, 2009; Scarpa et al., 2013)

The coefficient for the "optimal" animal welfare standard (0.29, SE = 0.15, $p < 0.05$) indicates that farmers exhibit a preference for higher (cf. basic) welfare standards when considering participation in animal welfare schemes. This shows that farmers are motivated by the ethical benefits of improved animal welfare, possibly due to increasing awareness of animal welfare issues. The importance of high welfare standards is in line with broader research indicating that farmers who recognize the benefits of improved welfare for animal productivity and marketability are more inclined to adopt such practices. For example, the International Livestock Research Institute (ILRI) has documented several case studies demonstrating the economic and productivity benefits of improving livestock welfare in the drylands of Africa. For example, providing appropriate shelter and feed management systems for dairy cattle (Qekwana et al., 2019).

The coefficient for 'enhanced' (cf. basic training) training (0.25, SE = 0.12, ***p < 0.01***) indicates that farmers are more likely to participate in animal welfare schemes that include training components. Training likely increases farmers' confidence in successfully implementing welfare practices, thereby reducing perceived risks. This finding aligns with evidence from Kenya, where farmers showed a strong preference for contracts that included knowledge transfer and capacity-building elements (Ochieng et al., 2017).

The coefficient for a three-year (cf. 1 year) contract duration (-0.41, SE = 0.16, ***p < 0.01***) suggests that farmers are less inclined to commit to longer contracts, possibly due to concerns about the risks and uncertainties associated with prolonged engagements. Shorter contract durations may be more attractive as they provide flexibility and reduce long-term risk exposure, a finding supported by similar research in contract farming contexts (Dang and Pham, 2022).

The financial incentives based on percentage livestock sales per annum (11.87, SE = 2.14, ***p < 0.001***) highlights that financial incentives are a critical driver for participation in animal welfare schemes. This underscores the importance of aligning welfare improvements with economic benefits, ensuring that farmers see a tangible return on their investment in welfare practices. This finding aligns with broader evidence from contract farming studies, where financial incentives are consistently shown to be the most influential factor in contract acceptance (Meemken and Bellemare, 2020).

The significant standard deviations for several attributes, including animal welfare standards, training, and incentives, indicated substantial unobserved heterogeneity in preferences among respondents. This refers to variations in preferences that are not captured or explained by the measured attributes in the DCE. These latent factors shape how individuals perceive and prioritize different contract attributes, resulting in diverse preference patterns across respondents. These findings are consistent with the broader literature on preference heterogeneity in agricultural contracts, which emphasizes the importance of designing flexible contract terms that accommodate diverse farmer preferences (Haile et al., 2019).

Table 6: Mixed logit model in preference space.

Coefficient Mean	Coef.	SE
Animal Welfare Standard (enhanced)	0.02	0.15
Animal welfare Standard (optimal)	0.29*	0.15
Training (enhanced training)	0.25**	0.12
Recognition (public acknowledgment)	-0.11	0.17
Contract duration (two years)	-0.09	0.21
Contract duration (three years)	-0.41**	0.16

Coefficient Mean	Coef.	SE
Contract duration (four years)	-0.16	0.14
Community involvement (community based)	0.20	0.15
Incentive (Percentage of livestock sales/year)	11.87***	2.14
Optout	0.77***	0.31
Coefficient standard deviation (Unobserved heterogeneity in mean)		
Optout	2.40	0.32
Animal Welfare Standard (enhanced)	0.81***	0.21
Animal welfare Standard (optimal)	0.89***	0.21
Training (enhanced training)	0.52***	0.20
Recognition (public acknowledgment)	1.06***	0.18
Contract duration (two years)	-0.49	0.45
Contract duration (three years)	0.21	0.59
Contract duration (four years)	-0.48	0.30
Community involvement (community based)	1.06***	0.19
Incentive (Percentage of livestock sales/year)	15.35***	2.17
Observation		1200
BIC		2382.89
AIC		2258.55

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. SE denotes Standard Error. AIC denotes Akaike Information Criterion. BIC denotes Bayesian Information Criterion.
Source: Author own work

Willingness to accept measures

We report the results of the RPL models estimated in WTP space over 2000 Halton random draws (Table 7). The analysis estimates farmers WTA measures providing insight into the compensation farmers would require engaging in animal welfare schemes.

Farmers would require compensation equivalent to 11% of their annual livestock sales to agree to participate in the animal welfare scheme. This indicates a strong aversion to increasing the incentive percentage, reflecting farmers' concern over additional financial burdens without proportional benefits. Research in Kenya indicated that smallholder livestock farmers were motivated to enhance welfare standards when provided with financial incentives or market premiums for high-welfare products. This emphasizes the economic challenge of adopting optimal welfare standards without adequate compensation or external support (Swanson, 2024).

Farmers would require compensation equivalent to 25% of livestock sales/year to accept optimal (cf. basic) animal welfare standards. This is consistent with findings from emerging economies, financial incentives remain a crucial enabler for animal welfare adoption, suggesting that compensation mechanisms must be tailored to the socio-economic and market factors of smallholder systems. This aligns with insights from Sinclair et al. (2022), who found that livestock

stakeholders in India and Bangladesh ranked financial benefits such as productivity gains and meat quality improvements as the strongest motivators for improving animal welfare.

Farmers would require 26% of livestock sales per year to participate in enhanced (cf. basic) training on animal welfare, implying the significant time and resource commitments these programs entail. The need for practical, benefit-driven training is essential in such contexts, where farmers often weigh the opportunity costs of their time and resources carefully.

The marginal WTA for public recognition is about 12% of livestock sales per year. This means that, on average farmers would need compensation equal to 12% of their yearly livestock sales to give up public recognition in the animal welfare program.

Farmers require substantial compensation equivalent to 40% of annual livestock sales for committing to a three-year contract, The relatively high WTA for the three-year contract suggests farmers' reluctance towards longer commitments, possibly due to uncertainties related to weather, market fluctuations, and policy changes. Research has shown that these uncertainties are particularly salient in developing countries and influence farmers' decisions regarding contract duration. This requirement aligns with studies showing that producers are more likely to adopt stringent welfare standards when the compensation reflects both the financial commitment and the stability offered by the contract (Turan et al., 2019).

Farmers would require significant compensation of 17% of livestock sales per year to engage in community-based animal welfare schemes. This result highlights a reluctance towards collective action, probably due to concerns about equitable benefit distribution or potential failures observed, for instance, in the context of agri-environmental schemes. The study by Riley et al. (2018) indicated that there was low uptake of collective agreements among farmers due to a shift towards individualistic approaches in land management because of decline in community-level trust over time.

Table 7: Mixed logit in Willingness to Pay Space

Coefficient Mean	Estimate	SE
Incentive (Percentage of livestock sales/year)	-0.09***	0.01
Optout	-6.76**	2.77
Animal Welfare Standard (enhanced)	0.04	1.35
Animal Welfare Standard (optimal)	-2.25*	1.37
Training (enhanced training)	-2.42**	1.07

Coefficient Mean	Estimate	SE
Recognition (public acknowledgment)	1.14	1.45
Contract duration (two years)	1.18	1.82
Contract duration (three years)	3.67***	1.42
Contract duration (four years)	0.81	1.26
Community involvement (community based)	-1.61	1.30
Coefficient standard deviation (Unobserved heterogeneity in mean)		
Optout	-22.57***	3.33
Animal Welfare Standard (enhanced)	-6.30***	1.99
Animal welfare Standard (optimal)	7.22***	1.94
Training (enhancedtraining)	-3.99*	2.09
Recognition (publicacknowledgm~t)	9.01***	1.82
Contract duration (twoyears)	1.36	5.08
Contract duration (threeyears)	1.36	4.20
Contract duration (fouryears)	3.14	2.70
Community involvement(communitybased)	-8.40***	1.82
Observations:	1200	
AIC	2332.4	
BIC	2429.7	

Note: * p < 0.10, ** p < 0.05, *** p < 0.01. RPL with independent random coefficients, SE stands for Standard error; AIC stands for Akaike Information Criterion; and BIC stands for Bayesian Information Criterion.
Source: Author own work

Understanding preferences and implications for implementation

The findings indicate a complex mix of motivations and constraints shaping the preferences of farmers for animal welfare schemes. The strong preference for financial incentives reinforces the reality that economic viability remains the main motivator for farmer participation in animal welfare initiatives. This finding aligns with previous research in similar contexts, where market premiums or government subsidies have been shown to be key enablers for sustained welfare improvements (Grethe, 2017). However, despite the attractiveness of such incentives, the high variability in household income and livestock ownership observed in our sample, combined with logistical barriers such as veterinary service centers 78.33 walking minutes away, raises significant concerns about the practical capacity of farmers to maintain welfare improvements once adopted.

Similar observation has already been reported in a recent finding that distance to veterinary centers significantly reduces both service uptake and efficacy, with around 30 % of farmers citing distance as a key deterrent (Kitole, 2025).

The aversion to three-year contracts highlights a rational response to risk. In a setting where climate shocks, market volatility, and policy changes are common, long agreements can act as deterrents. As highlighted by the National Sustainable Agriculture Coalition, sudden weather events and abrupt policy changes can significantly disrupt agricultural price stability and production outcomes (Opdenbosch et al., 2024). In such a context, long-term agreements can hardly be reliable guarantees for smallholder farmers. Flexibility in contractual arrangements is not merely a preference; it is a necessity for resilience and adaptability. Consequently, animal welfare programs should prioritize renewable contracts for one-year or seasonal pilot initiatives, which offer the responsiveness needed to navigate ongoing risks while supporting farmer welfare.

Moreover, the reluctance to participate in community-based schemes may reflect a lack of trust in collective governance structures or a stronger preference for individual autonomy patterns observed in other parts of sub-Saharan Africa. For example, Fidler et al. (2024) reported that community engagement in conservation efforts is highly dependent on both individual and collective empowerment, as well as the perceived fairness and inclusivity of local governance. Without transparent structures and shared benefits that foster trust and a sense of agency, such community-based initiatives are unlikely to gain meaningful local support or long-term sustainability.

These results imply that offering training or incentives alone will be insufficient. Effective welfare programs must be embedded in broader development support that improves access to markets, veterinary services, and credit access. Policymakers and NGOs must assess both what farmers need to adopt welfare practices and what institutions must do to support them.

[3]Chapter 5: Welfare and trader behavior in livestock markets (Study 2)

This chapter presents findings from a market-based study assessing animal welfare conditions and trader practices in Ethiopia's three-tiered livestock market system. The chapter provides a detailed overview of the main results with a discussion of the implications of these findings.

5.1. Results and discussion

Market roles and gender

Analysis of market actors (farmers, traders, suppliers and others) and gender distribution across the three markets is shown in figure 2 (Appendix). In all three towns, males dominate the market participation particularly as traders followed by farmers and suppliers, depending on the market type. A statistically significant association between market actors and gender was found in Adama (secondary market) (χ^2 (3) = 14.81, p = 0.002), indicating that males predominantly occupied the roles of traders and suppliers. However, in Meki (local market) (p = 0.297) and Addis Ababa (terminal market) (p = 0.470), no significant gender-based differences were observed. Females are present in lower proportions and mainly as traders, with less representation in other categories.

[3] The second study assesses the welfare conditions of small ruminants in live animal markets, with the manuscript submitted to the *Applied Animal Welfare Science Journal*.

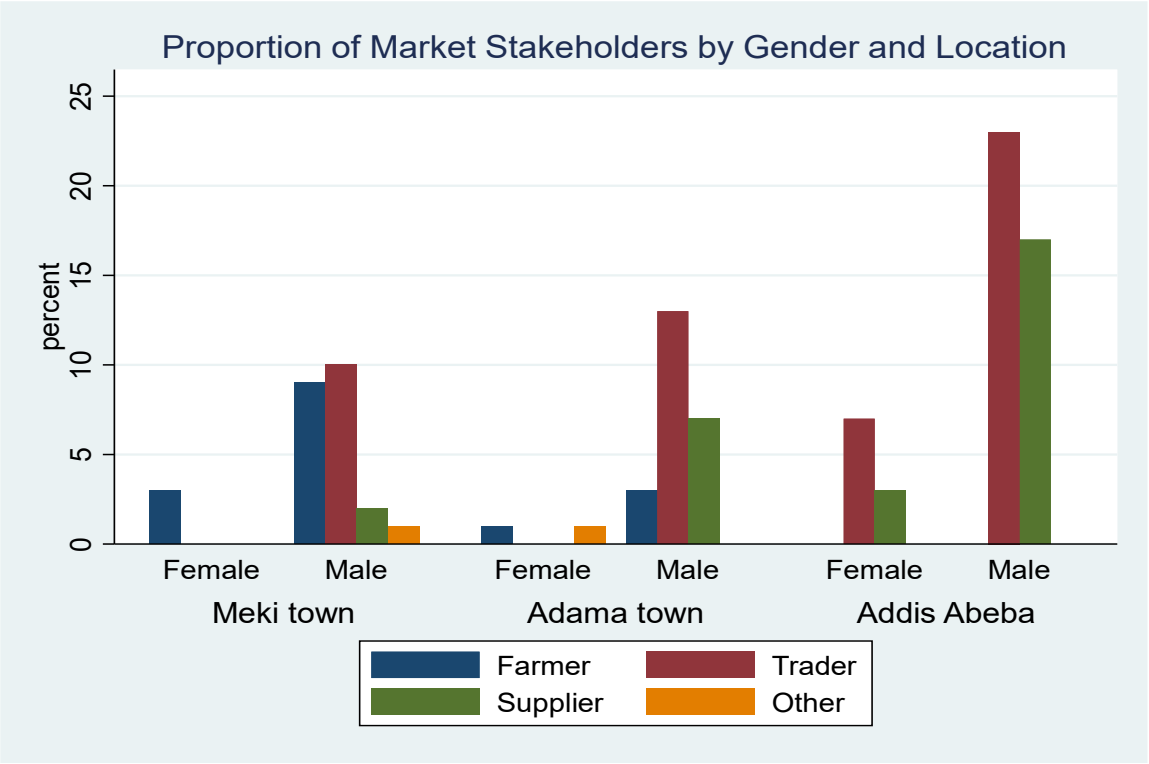

Figure 2: Distribution of market roles across three Ethiopian towns.

Stakeholders are categorized as Farmers, Traders, and Suppliers. In all three towns, males dominate the market particularly in the role of Traders followed by Farmers or Suppliers, depending on the location. Females are present in lower proportions mainly in the role of Traders, with minimal representation in other categories.

Animal market variability across towns

A comparative analysis of sheep and goat marketing across three markets reveals notable differences in market type (Figure 3). Addis Ababa (terminal market type) displays the widest interquartile range (IQR) for both species, indicating higher variability in traded volumes. The presence of outliers, particularly in goat transactions, suggests occasional spikes in activity beyond typical levels. In contrast, Meki (local market) demonstrates the narrowest IQR for sheep, pointing to relatively stable but smaller-scale trade. Median values for sheep are comparable across towns, while goat medians are notably higher in Addis Ababa, suggesting consistently larger volumes. These patterns underscore Addis Ababa's role as a central and more volatile livestock trading hub.

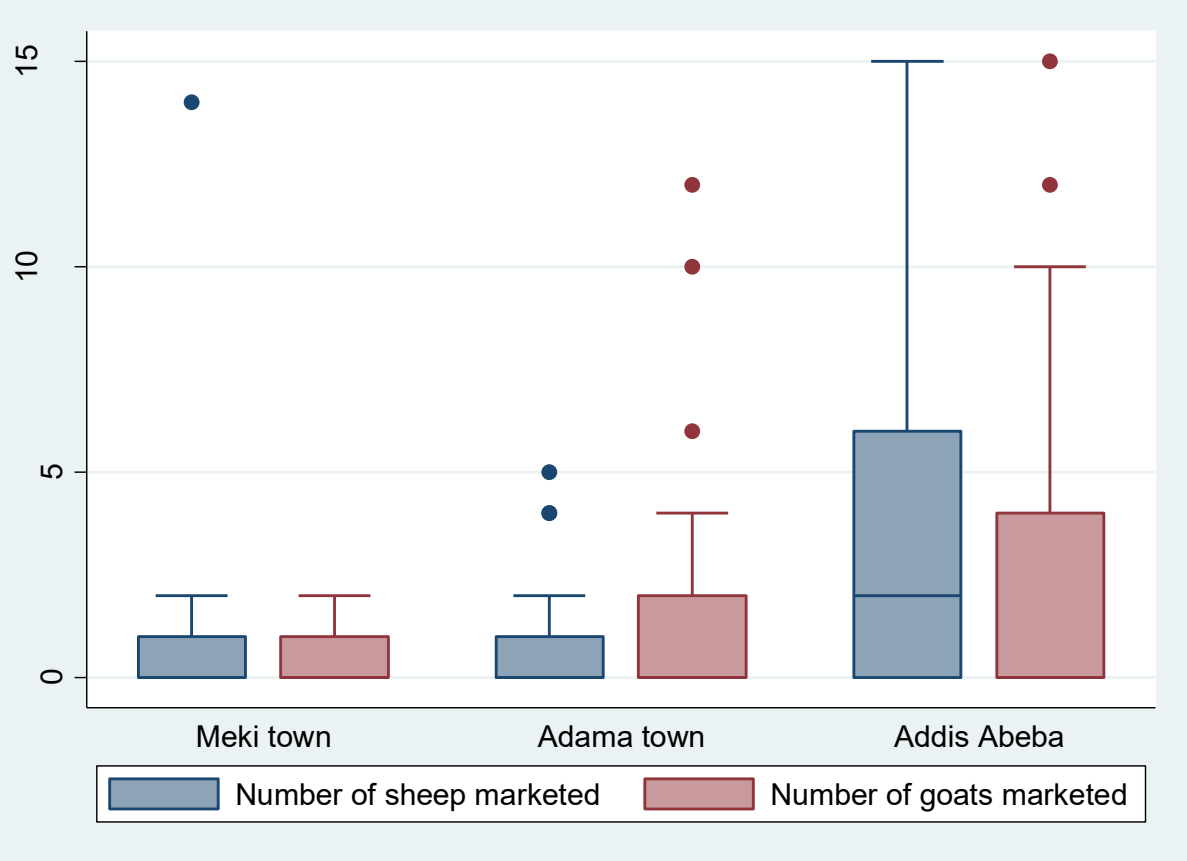

Figure 3: Marketing trends of sheep and goats.

Marketing trends of sheep and goats across three market systems (Meki (local market); Adama (secondary market); and Addis Ababa (terminal market). Boxplots show the distribution of the number of animals traded in Addis Ababa, Meki, and Adama per transaction. The interquartile range (IQR) captures the middle 50% of observed values; the median is indicated by the horizontal line within each box. Outliers represent atypically high transaction volumes.

Demographics and transportation practices

Table 8 presents the demographics, experience, and outcomes associated with livestock transportation among the group of respondents. The average experience is 3.5 years with a range from no experience up to a decade of experience in transporting animals.

The transport duration, averages 0.68 hour with a maximum of 2 hours, implying that most transports are relatively short. Stress and discomfort were observed in about half of the transport instances. On average, 0.93% of animals died during transport, and 1.01 % were injured, with maximum recorded number reaching 4 for deaths and 5 for injuries.

Table 8: Description of variables on transporters' demography, animals and transportation outcomes regarding duration, morbidity and mortality of the transported animals as self-reported by the stakeholders in the interview

Variable	Mean/%	Std. Dev.	Min	Max
Age of person responsible for transport	39.51	10.72	21	60
Years of experience in transporting animals	3.52	2.16	0	10
Number of sheep transported per transport	7.58	8.44	0	30
Number of goats transported per transport	5.29	8.13	0	40
Transport duration (hrs)	0.68	0.67	0	2
Percentages of the animals died	0.93%	4.33	0	4
Percentage of animals injured	1.01%	4.7	0	5

Source: Author own work

Impact of transport conditions on indicators of animal stress

Table 9 presents the results of a logistic regression analysis examining the relationship between transport characteristics and transport conditions with the likelihood of *self-reported* stress or discomfort in sheep and goats during transport. The model was statistically significant (χ^2 (5) = 30.83, $p < 0.001$), with a Pseudo R^2 of 0.223, indicating model fit. Among the predictors, transport duration emerged as the only statistically significant factor ($\beta = 2.09$, $p < 0.001$), suggesting that longer transport times substantially increase the odds of animals exhibiting stress-related behaviours.

Table 9: Logistic regression analysis of factors associated with animal stress or discomfort during transport.

Predictor	Coefficient (β)	Std. Error	z-value	p-value	95% CI
Years of experience	-0.070	0.113	-0.62	0.536	[-0.292, 0.152]
Gender (Male)	0.472	0.720	0.66	0.512	[-0.939, 1.883]
Transport duration (hrs)	2.089	0.451	4.64	0.000	[1.205, 2.972]
Sheep transported	-0.055	0.035	-1.58	0.115	[-0.123, 0.013]
Goat transported	-0.050	0.034	-1.49	0.136	[-0.117, 0.016]
Constant	-0.628	0.762	-0.82	0.410	[-2.121, 0.865]

Results from a logistic regression model evaluating the association between handler characteristics and transport conditions with the likelihood of self-reported stress or discomfort in animals during transport. Transport duration was the only factor significantly associated with higher odds of reported stress ($p < 0.001$).

Animal handling practices

Table 10 highlights significant differences in animal-handling practices across market types (χ^2 (6) = 28.50, $p < 0.001$). Terminal markets showed a strong preference for humane handling, with most respondents reporting the use of low-stress techniques. In contrast, local and secondary markets were more likely to employ rushed or stressful handling methods, including moving animals quickly regardless of conditions and using loud noises. These patterns underscore the influence of market structure and regulation on welfare-related behaviours.

Table 10: Distribution of animal handling practices by market type.

Animal handling practices	Local market (n = 25)	Secondary market (n = 25)	Terminal market (n = 50)	Total (n = 100)
Using loud noises or shouting to move animals	5 (20 %)	3 (12%)	2 (4%)	10
Applying low-stress handling techniques to move animals	6 (24%)	12 (48%)	41(82%)	59
Keeping animals separated from other animals	3(12%)	1(4%)	4(8%)	8
Moving animals as quickly as possible regardless of conditions	11 (44%)	9 (36%)	3 (6%)	23

Values are frequency and column percentage (n %) for each handling practice within market types (columns sum to 100 %). Pearson chi-square test demonstrated a significant association between market level and handling practice ($\chi^2(6) = 28.4995$, Pr = 0.000).

Animal loading practices

As shown in Table 11, Animal-loading practices varied significantly by market type (χ^2 (6) = 41.50, $p < 0.001$), with terminal markets showing markedly better welfare standards. Notably, loaded calmly and with care to avoid stress was most common in terminal markets, while pre-transport rest was often neglected in local markets. The use of force and loading unfamiliar mixed groups occurred more frequently in secondary markets, indicating inconsistent adherence to best practices across market levels.

Table 11: Frequencies and column percentages of animal loading practices.

Loading practices	Local market (n = 25)	Secondary market (n = 25)	Terminal market (n = 50)	Total (N = 100)
using force and pressure to load animals quickly	3 (12 %)	8 (32 %)	4 (8 %)	15
ensuring animals are loaded calmly and with care to avoid stress	8 (32 %)	12 (48 %)	39 (78 %)	59
loading animals without any pre-transport rest	12 (48 %)	1 (4 %)	1 (2 %)	14

Loading practices	Local market (n = 25)	Secondary market (n = 25)	Terminal market (n = 50)	Total (N = 100)
loading animals in mixed groups unfamiliar with each other	2 (8 %)	4 (16 %)	6 (12 %)	12

Distribution of four animal-loading methods across local, secondary and terminal market types. Values are presented as number of respondents (column percentages in parentheses). A Pearson chi-square test indicates a significant association between market type and loading practice ($\chi^2_6 = 41.50$, $p < 0.001$).

Animal unloading practices

Table 12 shows a significant association between market type and unloading practices (χ^2 (6) = 26.88, $p < 0.001$). Terminal markets were notably more likely to follow better unloading practices, with the majority of respondents reporting calm and careful handling. In contrast, cost-driven and stress-inducing methods such as rapid unloading and ignoring animal stress—were more frequently reported in local and secondary markets. Provision of water and rest post-unloading remained low across all market types.

Table 12: Distribution of animal unloading methods by market. (column percentages; N = 100)

Unloading practices	Local market (n = 25)	Secondary market (n = 25)	Terminal market (n = 50)	Total (N = 100)
unload quickly to minimize transport costs	9 (36 %)	5 (20.0 %)	4 (8.0 %)	18 (18.0 %)
unload calmly and carefully	10 (40 %)	11 (44.0 %)	44 (88.0 %)	65 (65.0 %)
unload without providing water or rest	1 (4.0 %)	2 (8.0 %)	0	3 (3.0 %)
unload regardless of animal stress.	5 (20.0 %)	7 (28.0%)	2 (4.0 %)	14 (14.0 %)

For each unloading practices column percentages indicate the proportion of respondents located in the local market, secondary market and terminal market. Pearson chi2 test demonstrated a significant association between market and chosen unloading practices ($p < 0.001$).

Factors influencing the number of animals sold

Table 13 presents the results of a cross-sectional Poisson regression analysis examining factors associated with the number of animals sold per transaction. Several variables show statistically significant associations with higher expected counts, including male respondents, suppliers and traders (relative to farmers), operations in Addis Ababa, provision of water during transport, and better animal body condition.

In contrast, the absence of welfare measures and poor body condition are associated with significantly lower expected numbers of animals sold. These results reflect multiplicative effects on expected counts, as indicated by the incidence rate ratios (IRRs), and should be interpreted as associations rather than causal effects given the cross-sectional nature of the data.

Table 13: Poisson regression analysis of factors influencing the number of animals sold.

Predictor	Coefficient (SE)	z	pp	IRR	95% CI IRR
Gender {male: ref. female}	1.224 (0.222) ***	5.52	<0.001	3.40	2.20–5.25
Market actors {supplier: ref. farmer}	0.699 (0.149) ***	4.70	<0.001	2.01	1.50–2.69
Trader	0.373 (0.102) ***	3.68	<0.001	1.45	1.19–1.77
Location {Addis Abeba}	0.251 (0.108) *	2.33	0.020	1.29	1.04–1.59
Welfare measure {No measure: ref. feed}	–0.633 (0.146) ***	–4.34	<0.001	0.53	0.40–0.71
rest stops	–0.085 (0.123)	–0.69	0.488	0.92	0.72–1.17
Water	0.454 (0.114) ***	3.97	<0.001	1.57	1.26–1.97
Body condition {normal: ref. fat}	–0.807 (0.087) ***	–9.26	<0.001	0.45	0.38–0.53
Thin	–2.051 (0.164) ***	–12.51	<0.001	0.13	0.09–0.18

Number of Observations: 100
Log Likelihood: –211.328
* p<0.05p<0.05p<0.05; ** p<0.01p<0.01p<0.01; *** p<0.001p<0.001p<0.001

Incidence-rate ratios (IRR) represent the multiplicative change in the expected count for a one-unit increase; P-values test each effect's statistical significance.

Comparative assessment of animal welfare across markets

The figure 4 shows the comparison between animal welfare scores in three markets based on the Five Freedoms Framework. Addis Abeba market demonstrated the highest overall welfare score (2.4), approaching the "Good" welfare range, indicating relatively favourable conditions. Adama market had moderate welfare (1.9), while Meki market scored the lowest (1.4), falling within the "Poor" welfare category.

Across all markets, the most consistently low-scoring freedoms were Freedom from Fear and Distress and Freedom from Discomfort, with many animals exposed to harsh environments,

overcrowding, and rough handling. In contrast, Freedom from Pain, Injury, or Disease scored relatively higher in Addis Abeba (terminal market) and Meki (local market), suggesting fewer visible injuries or illness in these markets. The ability to express normal behaviour was at a moderate level in Addis Abeba but severely restricted in the other two markets.

The ability to express normal behavior was moderately supported in Addis Abeba and Adama markets, both scoring 2, indicating that some animals had opportunities to move freely and interact. However, in Meki, this freedom was more limited (score 1.5), indicating restrictions on movement and social behavior.

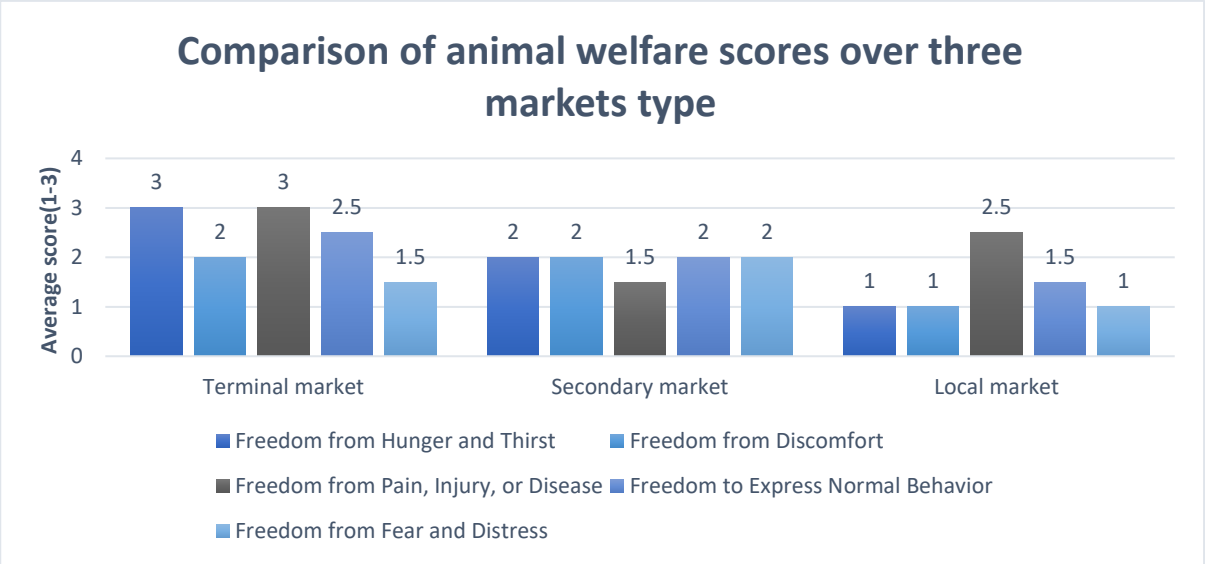

Figure 4: Comparison of average animal welfare scores across three livestock markets.

Each bar represents the average welfare score for each market. The y-axis defines overall welfare conditions as: Poor (1.0–1.5), Moderate (1.6–2.4), and Good (2.5–3.0). Addis Abeba (terminal market) shows generally higher welfare scores compared to Adama secondary market and Meki (local market), with Meki exhibiting the poorest overall conditions.

The impact of handling practices on animals and market outcomes

This study highlights the contrast between the welfare practices in terminal market and the local and secondary markets respectively. Poor practices such as forceful handling, lack of rest, and quick unloading result in significant stress for animals, leading to increased cortisol levels, reduced immunity, and greater susceptibility to disease (Diro et al., 2021). This in turn, negatively impacts meat quality, often resulting in dark, firm, and dry meat, which diminishes its market value (Sullivan et al., 2023) . Conversely, Addis Ababa's low-stress techniques, including better handling and water provision, reduce stress, improve meat quality, and increase economic returns. This

aligns with findings that humane practices boost productivity and profitability(Jardim et al., 2022; Petherick et al., 2009).

Infrastructure and welfare standards

Infrastructure is foundational to welfare and market efficiency. Terminal market provision of water, feed, and better transport systems ensures reduced animal stress and increase market volumes. In contrast, local and secondary markets suffer from a lack of basic facilities such as shelter and water, exacerbating dehydration, injuries, and mortality (Gallo and Huertas, 2016). This study reported relatively low transport-related mortality (0.93%) and injury rates (1.01%), likely due to shorter average transport durations (mean = 0.68 hours). The absence of proper transport systems in these markets further compounds welfare issues, as animals endure long and stressful journeys to markets, sometimes resulting in mortality rates as high as 16% during transit (Bulitta et al., 2012) and the mortality rates reported ranging from 1.2% to over 5% (Padalino et al., 2018).

While the use of efficient transport systems such as lorries have been shown to reduce losses and enhance both welfare and productivity(Grandin, 2008; Knowles, 1998), these remain underutilized in most local and secondary market type.

The Five Freedoms framework provides a useful benchmark to assess welfare practices across markets. Terminal market demonstrates higher compliance, especially in ensuring freedom from hunger and thirst and freedom from pain, injury, or disease. However, it falls short in addressing freedom from fear and distress, a critical component of animal welfare. However, this aspect could be improved without costly infrastructure changes, e.g. by adopting handling practices. In contrast, the local market demonstrates consistently poor welfare outcomes across all domains with particularly low scores in freedom from hunger, thirst, and discomfort. The secondary market performs moderate across most dimensions but exhibits a notably low score in the domain of freedom from pain, injury, or disease. These deficiencies highlight the need for policy reforms and infrastructure improvements to align rural market practices with acceptable welfare standards(Grandin, 2010b).

Social and gender dynamics in livestock markets

The study highlights significant gender disparities in market participation, with male respondents dominating transactions due to better access to resources and training (Njuki and Sanginga, 2013). In contrast, women often face entrenched structural and socio-cultural barriers that restrict their engagement in high-value segments of the supply chain. These limitations not only curtail their

economic contributions but also result in underutilized potential for improving animal welfare and handling practices

Recent literature increasingly indicates that women demonstrate higher levels of empathy and more compassionate attitudes toward animals across diverse cultural settings. Numerous studies have identified a significant association between female gender and heightened concern for animal welfare, as well as stronger opposition to inhumane treatment. While empirical comparisons of animal handling practices between men and women are currently limited, the consistently observed attitudinal disparities suggest that greater representation of women in animal handling and caregiving roles may contribute to more humane treatment. Given that empathy is a critical determinant of welfare-oriented behaviour, its presence is likely to result in gentler and less stressful human animal interactions, thereby advancing both ethical standards and productivity outcomes (Muri et al., 2023; Randler et al., 2021)

Therefore, enhancing women's participation through gender-responsive policies including targeted training programs, improved credit access, and support their roles as traders and supplier not only advances equity but also offers a strategic pathway to elevate welfare standards: promoting animal well-being while also addressing gender-based inefficiencies in the value chain(Dulal, 2020; Paudyal et al., 2019) .

Policy and training as drivers of welfare improvement

The positive welfare practices observed in Addis Ababa highlight the importance of training handlers and implementing policies that support humane treatment. Research consistently shows that training handlers in minimal-stress techniques reduces stress markers like cortisol and improves meat quality(Grandin, 2020; Kumar et al., 2024). Policymakers must focus on building infrastructure, enforcing welfare standards, and promoting education to bridge the gaps in rural markets. These interventions not only enhance animal welfare but also improve economic outcomes by fostering sustainable and humane livestock practices (Adeboun et al., 2022; Gallo and Huertas, 2016).

[4]Chapter 6: Human-wildlife conflict and livelihood strategies (Study 3)

This chapter explores the dynamics of human-wildlife conflict (HWC) in and around Nech Sar National Park in Ethiopia. The chapter provides a detailed overview of the main results with a discussion of the implications of these findings.

6.1. Result and discussion

Study sample profile

Mean household size varied from 5-7 individuals. More than 22% (*n* = 17) of the household respondents were women and 77.6% (*n* = 59) were men. Approximately one third of household respondents (30.6%; *n* = 23) were between 20 and 35 years, whereas 53.3% (*n* = 40) were between 35 and 50 years and 16% (*n* = 16) were over 50 years. In terms of livelihoods, 77.3% of the households reported that they were subsistence agricultural farmers producing crops and livestock. The estimated average annual household income is 100.03 USD, with a standard deviation of 135.57 USD and a range of 0 to 748.50 USD. Cattle were the most numerous livestock species (total sum of animals from all surveyed households: n = 1,012), Goats (n = 251), Hens (n = 392), Sheep were less common (n = 38), and Donkeys were the least numerous (n=13). The other 15% households generated some income from sources outside their farming and 8 % accounts for herding livestock.

Human-wildlife conflict prevalence across local communities surrounding the Save Conservancy

All respondents (100%) reported experiencing human-wildlife conflicts, with unanimous agreement that these conflicts had increased between 2017 and 2022. In the Shecha and Chano Doriga kebeles there was 100% agreement, while Genita Kenchima and Shelle Mele had 90% and 93.3% agreement regarding the presence of predators (Figure 2), respectively.

All key informants (100%, *n* = 25) reported that human-wildlife conflicts were on an increasing trend of which 64% (*n* =13) of key informants felt human-wildlife conflicts were increasing due to growth of both human and wild animal population and the absence of an effective fence around the park.

[4] The third study explores human-wildlife conflict management in protected area buffer zones.

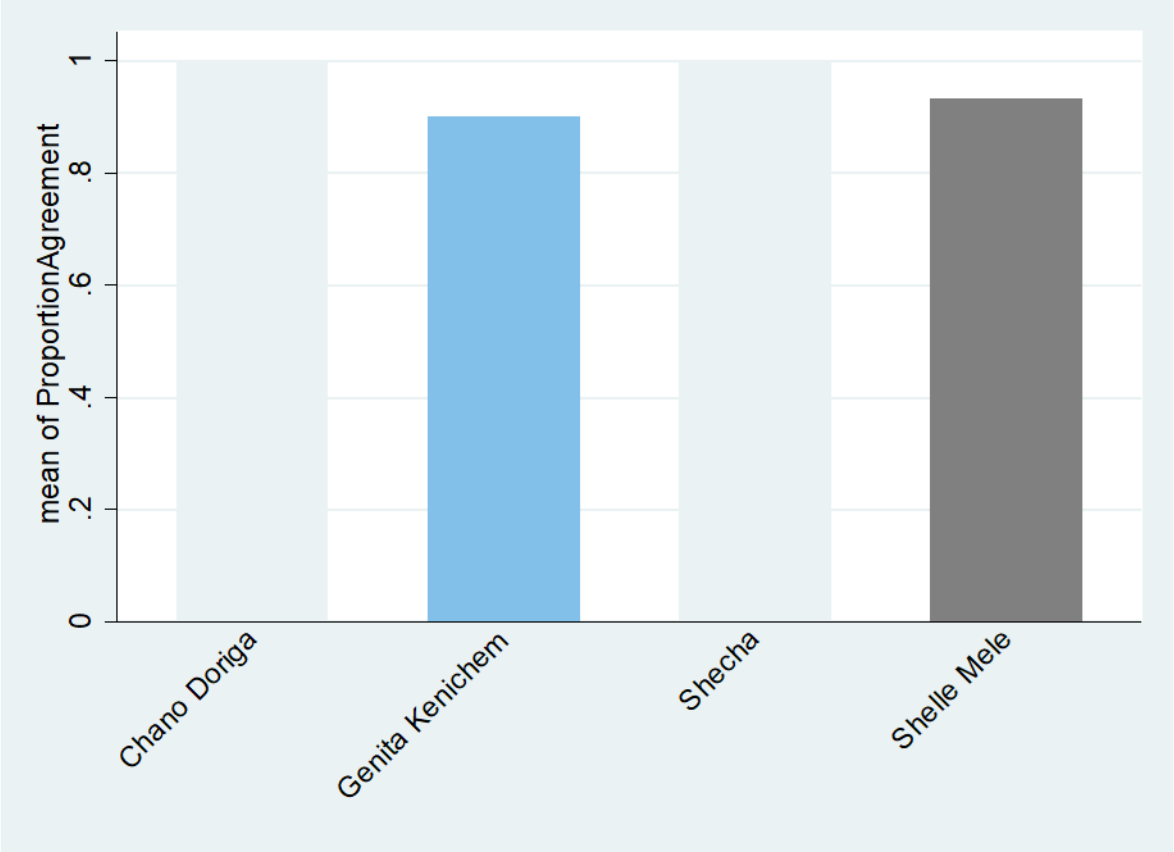

Figure 5: Proportion of agreement on the presence of predators on the selected districts.

The proportion of agreement on the y-axis represents the percentage of respondents in each kebele who agreed, calculated as the number of agreements divided by the total number of respondents

Type of animal species and nature of human-wildlife conflicts across the study area

Human-wildlife conflicts were assessed by summarizing all the problem wild animal control cases reported from July 2021 to January 2023 in the study area, where 76% (n = 57) of the cases were raids of agricultural crops such as maize, vegetables and fruits and fruits destroyed by Hippos and Monkeys. Most households of the study area (82.7%, n = 62) stated that Hyena, Leopard, Crocodiles, Hippos, and Monkeys were the main problem wild animals causing human-wild life conflicts (Table 14). Key informants from the study area (100%, n = 25) reported that wild species may prefer to invade Shecha, Chano Doriga and Genita Kenichema because they could be attracted to the crops grown there such as bananas, in the case of herbivorous hippo and monkey whereas carnivores were suggested to be attracted by the need to prey on livestock. Shecha kebele is closer to the boundary of Nech sar national park. There were significant differences (Chi2 (21) = 60.46;

df=1, p<0.001) in animals species causing human-wildlife conflicts in the study sites, although the pattern is not always consistent with the assumptions mentioned by the key informants.

Table 14: Frequency of wildlife species mentioned in human-wildlife conflicts by respondents by kebele

Wildlife Species	Shecha	Chano Doriga	Genita Kenichema	Shelle Mele	Total
Hyena	7	5	3	3	18
Crocodiles	0	6	6	0	12
Hippo	0	6	5	0	11
Monkey	4	1	3	2	10
Abyssinian Genet	1	2	0	7	10
Leopard	4	0	2	0	6
Lion	3	0	0	0	3
Hedgehog	1	0	3	1	5

shown are the number of participants reporting the different wildlife species as problematic in human-wildlife conflicts

Economic impact of human-wildlife conflict on the livelihoods

Most of the respondents interviewed (96%, n = 72) reported that they had experienced predation on their livestock, resulting in economic losses. There was no significant difference in the amount of livestock predation across the kebeles, but there were significant differences in crop damage and human attacks between the kebeles. The reported losses due to human-wildlife conflicts are shown in Table 15. The households reported killings of a total of 607 livestock at an average value of $383.98 per farm from the year 2017 to 2022, which amounts to an average of 76.78 USD per farm and per year. Based on survey responses, farming and small-scale trade are major income sources, with an average annual income of 100.03 USD. Thus, losing 76.78 USD per year constituted 76.75% of their annual income, demonstrating the tremendous impact HWC has on farmers' livelihoods. The average economic losses per year were significantly different across the distances between the park boundary and the four districts (Table 15). The highest means of total household economic loss was observed within 16 km of location from Nech Sar Park boundary and the community, and the lowest was observed at 20 to 25 km from the park boundary.

Many people living in and around the park did not own grazing land. Approximately 28% of respondents lived within the park and used it as a grazing field. Human settlement (33.33%),

agricultural practices (12.6%), overgrazing (14.4%), deforestation for charcoal production (36.04%) as well as deliberate fire to free lands for agriculture (3.6%) were noticed as major reasons why the predators move out of the park to prey on livestock. Key informants and the park administration witnessed that fields were used for agriculture within close distance of the park. Many wild herbivores were noticed to graze outside the park boundary. This condition favored predators to have double options; one is predating livestock grazing within the park or following the natural prey out of the park, which may alongside increase exposure of livestock grazing near and far from the park to predators.

Table 15: Relationship between household monetary (USD) loss and distance from the Nech-sar park boundary

Livestock species	Number of animals killed (within 5 years)	Average monetary loss per farm (within 5 years)	Average monetary loss per year
Cattle	108	243.12	48.62
Sheep	37	41.30	8.25
Goat	104	73.80	14.76
Donkey	4	3.71	0.74
Hens	354	22.05	4.41
Total	607	$383.98	$76.78

Distance between the community and park boundary	Mean total monetary loss per year	F, Prob>F
Shecha (16 km)	151.5$	4.08, 0.0098
Genita Kenchima (21 km)	25.8$	
Chano Dorigo (23 km)	45.9$	
Shelle Mele (26 km)	86.4$	

Source: Author own work

Gender and human-wildlife conflicts in Nech Sar national park

Livestock predation constitutes a critical dimension of human-wildlife conflicts, with differential impacts observed between male- and female-headed households. This study underscores gender-specific disparities in livestock predation and associated economic losses among the surveyed households. As shown in Table 16, male-headed households experienced significantly higher levels of cattle predation (mean =1.67) compared to female-headed households (mean = 0.65). This discrepancy extended to monetary losses, with males incurring an average loss of $292.12 per/year, while females reported losses averaging $75.95. The difference aligns with the common practice

of men managing larger herds of cattle, which are frequently grazed in wildlife-prone areas, increasing their exposure to predation.

Conversely, female-headed households faced significantly higher predation rates of hens (mean = 9.06) compared to male-headed households (mean = 3.45). Corresponding monetary losses were also higher for females, averaging $37.71 versus $17.47 for males. The result revealed those hens often kept near homesteads and predominantly managed by women, are more susceptible to predation by smaller predators such as Hedgehog and wild cats, which exploit their proximity to human settlements.

Figure 4 illustrates a significant gender disparity in the proportional impact of livestock predation, even when absolute monetary losses differ. While male respondents experience higher absolute losses in USD due to larger herds of cattle and goats, the proportional losses for women are markedly more severe, particularly in relation to hens. For example, women report a relative loss of 97.18% for hens, compared to 33.97% for men, highlighting the more substantial burden faced by women despite the lower absolute loss in monetary terms. This suggests that while men may face higher overall losses in monetary terms due to ownership of larger livestock, women are disproportionately affected in relative terms, particularly for smaller livestock that may constitute a more critical source of income and sustenance. This gender-specific impact underscores the importance of considering relative loss rather than just absolute figures when assessing the socio-economic effects of livestock predation.

Table 16: Gender differences in livestock predation and monetary loss

Livestock type	Unit (Predation: average number of animals/ five years) (Monetary loss: average USD/ five years)	Male	Female	Total	p-value
Cattle	Predation	1.67	0.65	1.44	0.0494
	Monetary loss	292.12	75.95	243.12	0.0303
Sheep	Predation	0.64	0	0.49	0.1721
	Monetary loss	53.40	0	41.29	0.3293
Goat	Predation	1.67	0.41	1.39	0.1284
	Monetary loss	88.24	24.55	73.80	0.3805
Donkey	Predation	0.07	0.	0.05	0.2719
	Monetary loss	4.81	0	3.72	0.5130

Livestock type	Unit (Predation: average number of animals/ five years) (Monetary loss: average USD/ five years)	Male	Female	Total	p-value
Hens	Predation	3.45	9.06	4.72	0.0095
	Monetary loss	17.47	37.71	22.05	0.0457

Source: Author own work

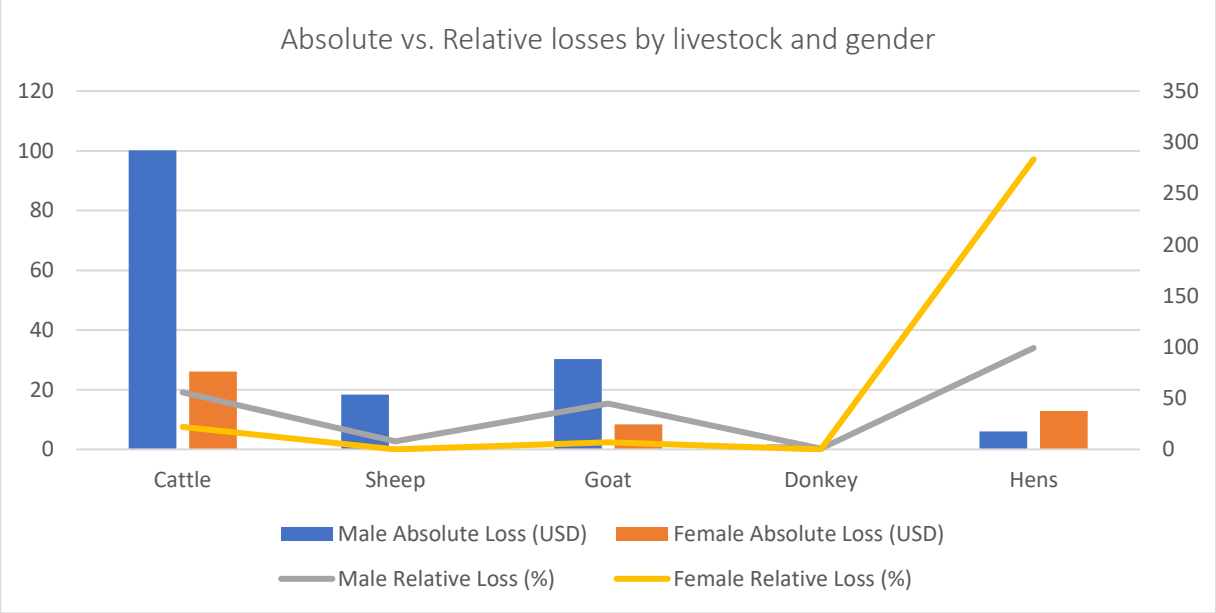

Figure 6: Gender differences by species in absolute and proportional livestock losses due to predation relative to total number of animals owned.

Economic incentive-based livestock housing for environmental conservation

The results in Table 17 demonstrate the distribution of respondents' agreement to suppositional plans for government-based economic incentive for building modern eco-friendly livestock pens (housing). Among the respondents, 89.47% of males and 88.24% of females agreed to adopt modern livestock housing, if the government covers 30% of the building cost. This indicates a high level of interest among both genders in implementing eco-friendly housing practices when economic support is provided. The economic incentive from the government would further alleviate the initial financial burden of adopting such infrastructure, allowing farmers to invest in eco-friendly livestock housing without compromising their economic viability (USAID, 2019)

Eco-friendly housing would curtail overgrazing, soil erosion and water pollution, reducing the adverse effects of livestock on the natural resources within and around the park. Embracing the government's subsidy would signify farmers' commitment to sustainable agriculture and

conservation, playing a crucial role in safeguarding Nech Sar National Park's ecological integrity for future generations.

Table 17: Respondents' agreement with suppositional government-based economic incentive for building eco-friendly livestock housing

Gender of the respondents	Yes (agreement)	No (disagreement)	Chi2
Male	51 (89.47%)	6 (10.53%)	0.0208, Pr = 0.885
Female	15 (88.24%)	2 (11.76%)	
Total	N=66	N= 8	

Source: Author own work

Traditional guarding measures on the prevention of livestock depredation

For several centuries, communities who settled at close distance from protected areas (parks), put into effect different predator controlling methods. The respondents interviewed mentioned eight major traditional guarding mechanisms they used to control predators, while 12.3% did not take any protection measures (Figure 5).

All key informants (100%, $n = 25$) suggested that there should be an increment of the size of the buffer zone area bordering around the surrounding area park, since wild animals easily stray into crop fields and livestock pasture fields. Approximately 64% of the interviewees believed that the traditional guarding measures were ineffective while the remaining respondents suggested the traditional guarding measures to be effective or very effective (table 5).

The ANOVA result indicate that guarding assessment has a statistically significant effect on livestock loss ($F(3,71) = 11.64$, $p < 0.001$). The mean livestock loss is highest when guarding assessment is very ineffective and with the lowest loss observed in the effective and very effective categories, suggesting that respondents correctly assess the effectiveness of their guarding measures. The communities suggested that local government, local traditional leaders and park officials should work together to help reduce human-wildlife conflicts.

Figure 5 presents boxplots illustrating the distribution of livestock losses associated with various conflict mitigation measures. For each method, the box represents the interquartile range (IQR), spanning from the first quartile (Q1) to the third quartile (Q3), which captures the middle 50% of the data. The vertical line within each box indicates the median livestock loss. Whiskers extend

from the box to the smallest and largest values within 1.5 times the IQR from Q1 and Q3, respectively. Data points that fall outside this range are plotted as individual dots and represent statistical outliers. These outliers reflect instances of unusually high or low livestock losses under a given mitigation strategy and are not indicative of data error. Herding, dog guarding, and thorn hedges are the most effective livestock protection measures, minimizing losses with low variability. Scarecrows, spear throwing, and battery lights offer moderate protection, while stone throwing and whip sounds exhibit higher variability and inconsistent effectiveness. The absence of guarding measures results in unpredictable and often higher livestock losses. Overall, proactive strategies such as herding, dog guarding, and physical barriers provide the most reliable protection against livestock loss (Figure 4).

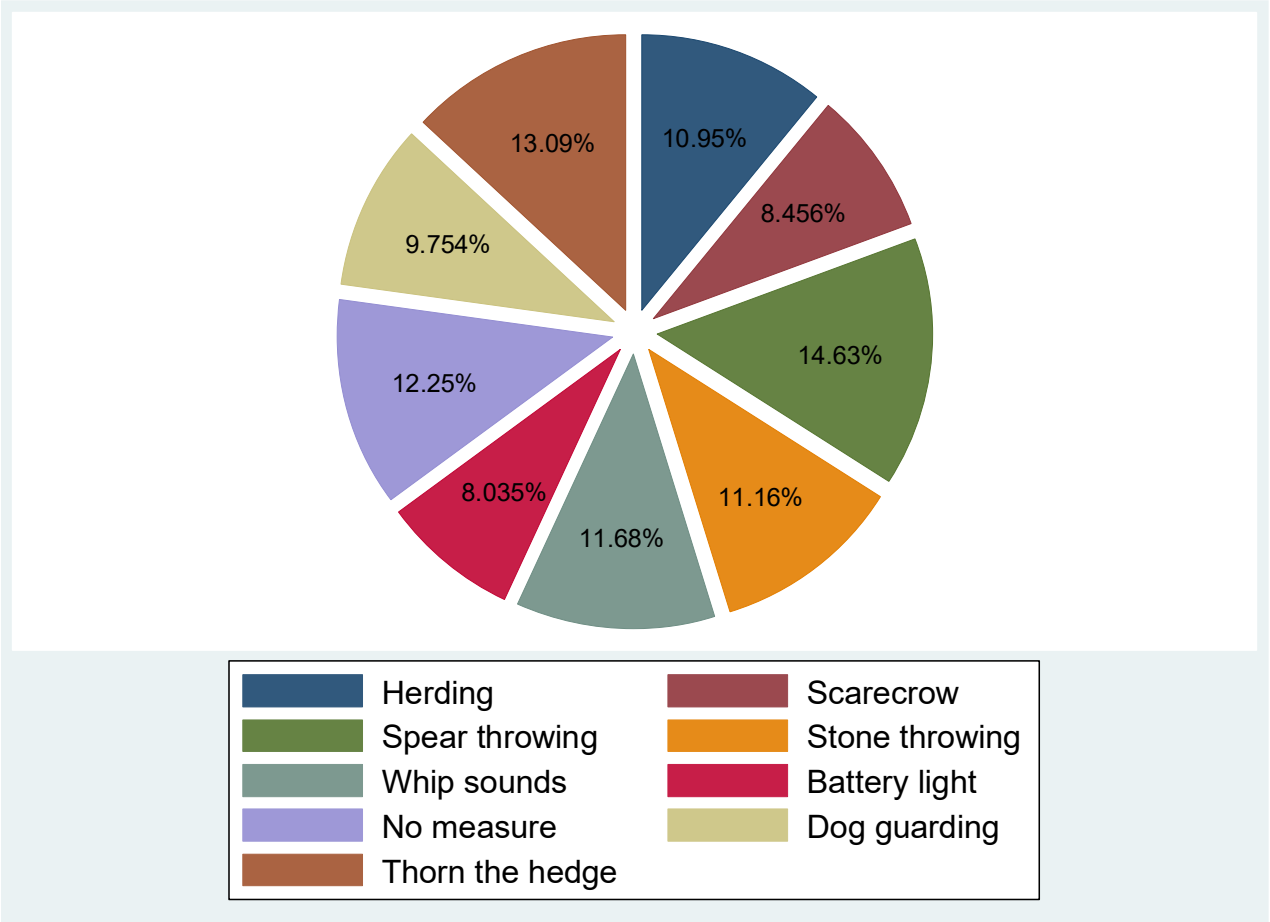

Figure 7: Distribution of guarding measures used by the respondents.

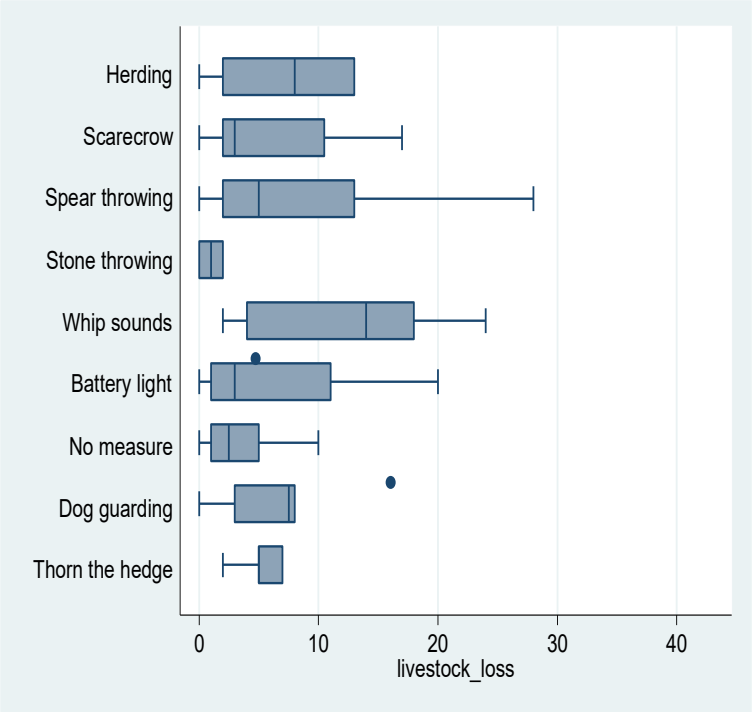

Figure 8: Boxplots for the proportion of livestock losses (in % of all animals owned) under different guarding measures

Strategies that strengthen the effectiveness of traditional guarding measures

The findings on the effectiveness of traditional guarding measures, such as livestock-guarding dogs and fencing, align with broader scientific literature, which highlights their potential for mitigating livestock depredation. Studies from Namibia and Botswana demonstrate that guarding dogs can significantly reduce predation rates—up to 91% and 85%, respectively—by fostering attentive and protective behaviors with proper training and care (Marker et al., 2021), (Weyde et al., 2020). These results resonate with global patterns where guarding dogs and modern methods like electrified fladry and tall fencing have shown success, albeit with variability depending on the predator species and ecological context (Bruns et al., 2020), (Samelius et al., 2021), as well as geographic location and the socio-economic context of the farmers. For example, localized adaptations, such as using indigenous dog breeds, have improved outcomes in resource-limited settings like Botswana, while studies in Europe suggest that combining traditional methods with modern deterrents enhances overall protection (Thapa, 2010).

However, discrepancies exist, as some measures, particularly fencing and deterrents, may require high investment costs or maintenance costs, making them less accessible to marginalized farmers. Furthermore, long-term success often depends on community involvement and policy support to foster coexistence between humans and wildlife (Miller et al., 2016). Policymakers can draw from

these findings to promote cost-effective, context-specific interventions and support knowledge-sharing initiatives between farmers and conservation managers. Farmers benefit from clear evidence that well-implemented guarding strategies can reduce losses, while policymakers must address financial and logistical barriers to ensure equitable access to these solutions. Integrating traditional methods with innovative practices will be crucial in reducing conflicts and supporting sustainable livelihoods.

Understanding the role of gender in human-wildlife conflicts on agriculture-based livelihood

Human-wildlife conflicts in developing countries often have gender-specific impacts on agriculture-based livelihoods. Studies indicate that women and men experience and perceive these conflicts differently, influenced by their distinct roles and responsibilities within their communities. Studies reveal that conservation strategies in Nech Sar often conflict with local livelihoods, exacerbating tensions and disproportionately affecting specific demographics, including women (Kelboro and Stellmacher, 2015).

Research indicates a clear gender divide into the impact of livestock predation. Male respondents report higher monetary losses due to cattle predation, reflecting their primary role in managing larger, more costly livestock. Conversely, female respondents experience greater losses of hens, aligning with their role in overseeing poultry and smaller-scale livestock. These patterns highlight the gendered division of labor and asset ownership in Ethiopia. Women's vulnerability to hen predation is further heightened by their proximity to the home, where poultry is typically kept, as noted in recent studies (Huluka, 2022).

The absence of participatory approaches in park management has exacerbated local dissatisfaction, with women disproportionately affected due to their dependence on small-scale agriculture and natural resources. Addressing these challenges requires gender-sensitive conservation strategies, such as compensation for losses and participatory resource-sharing mechanisms. Such initiatives can help mitigate the gendered impacts of human-wildlife conflicts and create more equitable solutions (Ayechew and Tolcha, 2020).

The economic loss of HWC is especially severe for women, who often lack alternative livelihood options. While ecotourism initiatives in Nech Sar National Park hold promises for generating income and reducing reliance on agriculture, cultural and institutional barriers limit women's participation. Addressing these barriers could unlock the potential of ecotourism as a sustainable livelihood source, promoting greater gender equity in the region (Fetene et al., 2012).

Economic incentives from the government for animal friendly livestock housing can also be seen as an endorsement of social acceptance and community engagement. A report published by the Scientific Advisory Board on Agricultural Policy (2015) reveals that farmers' decisions are often influenced by the opinions and practices of their peers within the community. When a significant number of farmers accept the government subsidy and invest in eco-friendly housing, it sets a positive example for others, creating a ripple effect of sustainable practices adoption. Therefore, community support and acceptance of eco-friendly initiatives can foster a sense of shared responsibility for the conservation of Nech Sar National Park and its resources, promoting a cooperative approach between farmers, the government, and conservation organizations (Scientific Advisory Board on Agricultural Policy, 2015)

Chapter 7: Conclusion and Recommendations

This dissertation presents an integrated analysis of key animal welfare and human-wildlife interaction challenges in Ethiopia's agricultural sector. Three interrelated studies reveal critical factors affecting voluntary animal welfare program participation, market-level welfare compliance, and human-wildlife conflicts (HWC) near protected areas. Together, the findings underscore the complexity of advancing animal welfare and rural livelihoods in Ethiopia, shaped by socio-economic conditions, institutional infrastructure, and ecological contexts.

The first study identifies that Ethiopian farmers are more likely to engage in voluntary animal welfare schemes when programs are designed with clear standards, financial incentives, and training tailored to their local situations. Flexibility in program design and a supportive community environment also play a role in fostering sustained participation. The second study reveals that welfare outcomes in livestock markets are highly dependent on infrastructure quality, regulatory enforcement, and local governance. Markets with improved facilities and oversight show greater compliance with humane handling practices. However, systemic violations of the Five Freedoms persist, especially regarding discomfort and constrained natural behaviors. The third study highlights how proximity to Nech Sar National Park intensifies HWC, with distinct gendered impacts and economic losses due to crop damage and livestock predation. Communities favor eco-friendly livestock housing and collaborative conservation strategies, pointing to scalable solutions that align conservation with rural development.

Based on the combined findings, the following recommendations are proposed:

1. **Incentivize Animal Welfare Programs**
    - Establish national animal welfare standards that are clear, realistic, and achievable for smallholder farmers.
    - Provide financial incentives linked to livestock production and sales to increase program uptake.
    - Design flexible contracts and incorporate community-based approaches to enhance participation and trust.
2. **Invest in Training and Infrastructure**
    - Deliver locally relevant training programs for farmers, market handlers, and transporters.

- Upgrade all levels of livestock markets with essential amenities such as water, shade, and holding pens.
- Develop transportation systems that reduce animal stress and injury, complemented by regular welfare audits.

3. **Address Market and Gender Dynamics**
   - Implement welfare certification schemes and strengthen local governance of livestock markets.
   - Integrate gender-sensitive approaches into all animal welfare and conservation programs. *Recognizing and addressing the specific roles and constraints of women and men especially in livestock care and human-wildlife conflict—leads to more responsive, effective, and durable outcomes. Gender-sensitive strategies strengthen social cohesion, reduce vulnerabilities and enhance program legitimacy and reach.*
   - Improve women's access to credit, training, and decision-making roles in livestock and conservation systems. *Empowered women contribute to better animal care, stronger household resilience and balanced decision-making in natural resource governance. This promotes not only gender equity but also more adaptive, inclusive, and effective conservation and development outcomes.*
4. **Mitigate Human-Wildlife Conflict with Community-Driven Solutions**
   - Expand and manage buffer zones around Nech Sar National Park to prevent wildlife encroachment.
   - Promote eco-friendly livestock housing using subsidies and technical support.
   - Replace or enhance traditional guarding techniques with modern deterrent technologies.
   - Establish compensation schemes that reflect the diverse economic impacts of HWC on different household types.
5. **Strengthening Institutional Frameworks and Collaboration**
   - Develop a comprehensive national animal welfare strategy with defined timelines, implementation guidelines, and monitoring systems.

- Facilitate partnerships among government agencies, conservation organizations, and local communities to ensure long-term support and accountability.

By implementing these integrated policy measures and interventions, Ethiopia can improve animal welfare standards, enhance rural livelihoods, reduce inequalities between men and woman and foster more sustainable coexistence between humans and wildlife. These findings offer a roadmap for policymakers, researchers, and development practitioners seeking to build resilient agricultural and conservation systems grounded in evidence and equity.

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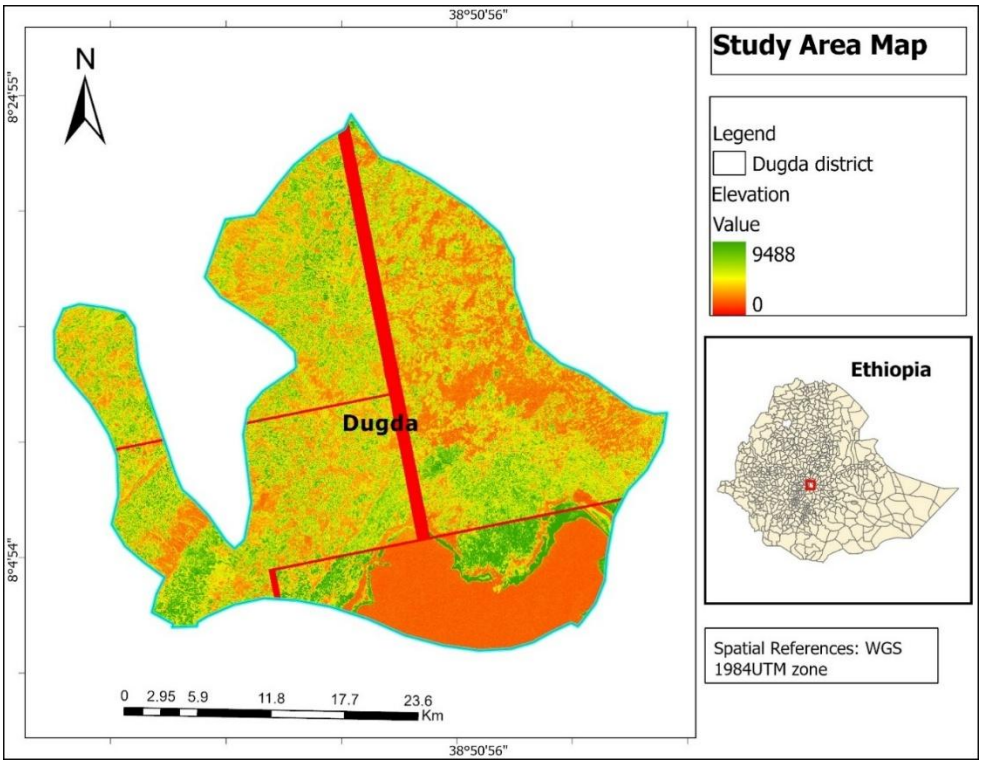
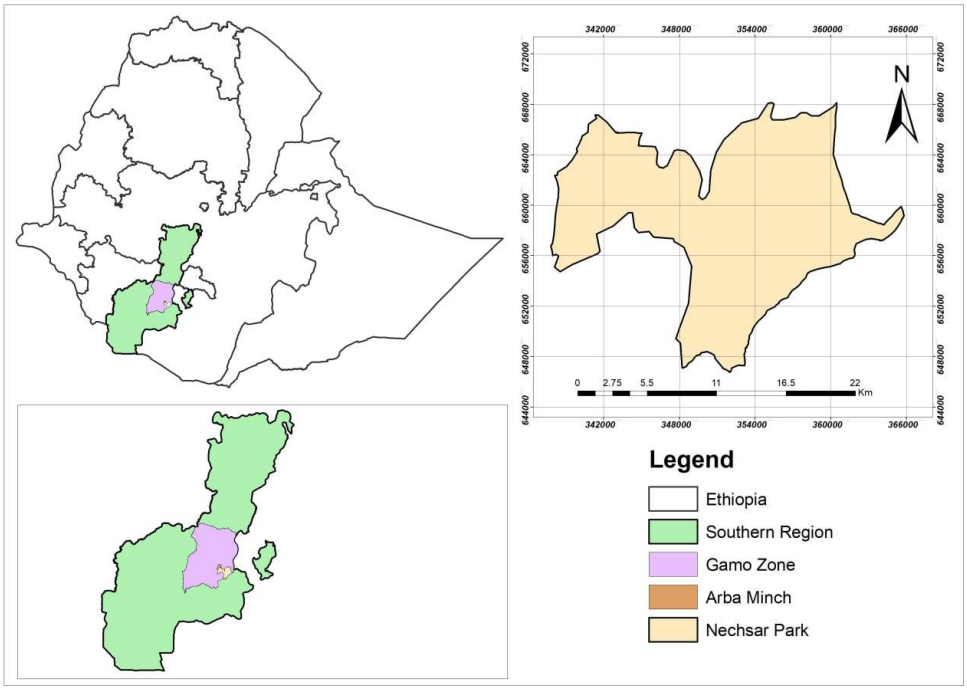
Appendices



Appendix A: A map of Ethiopia and the region.



Appendix B: The location of Nech Sar national park in southern Nation Nationalities Regional State, Ethiopia.

PART 0. INTERVIEW BACKGROUND

1. Respondent's name: .....
2. Mobile phone No……
3. Date of interview: Day: …..…… Month: ..... Year: …….……
4. Interviewed by (enumerator's name): …..... signature.....
5. Date checked: Day: ……..…..…… Month: ..... Year: …….……
6. Checked by (supervisor's name) .....signature.....
7. Date entered: Day: …….…… Month: ..... Year: ……..……
8. Entered by:…….…….....
9. Region.....
10. Zone.....
11. District: …..……..……..…..…..……..……..
12. Peasant Association …..……
13. Village.....

PART 1: FARMERS IDENTIFICATION AND VILLAGE CHARACTERISTICS

Major family language (Codes A).....

Which inbuilt structure does the main residential house has (circle)? 1. Kitchen? ____ 2. Grain store? _____

3. Poultry perch? _____ 4. Other type of livestock pen? _____ (Codes B)

Type of toilet used .....1. Flush toilet private; 2. Flush toilet shared; 3. Pit latrine private; 4. Pit latrine shared; 5. Bucket latrine; 6. No toilet/use open air

Main walling material of main residential house……..... (Codes C)

Main roofing material of main residential house…… (Codes D)

Taking into consideration all food sources (own food production + food purchase + help from different sources + food hunted from forest and lakes, etc), how would you define your family's food consumption in the last year? (Codes E).....

Distance to the village market from residence (km) .....minutes of walking time.....

What means of transport do you use mainly to get to the village market? (Code F)……

Average single trip transport cost (per person) to the village market using this means of transport (ETB/person)

Distance to the nearest main market from residence (km)……minutes of walking time……..

Number of month's road to main market is passable for cars in a year.....

Quality of road to the main market (Codes G)…….…….....

Average single transport cost (per person) to the main market using a car (ETB/person).....

Distance to the nearest veterinary service from residence (km)……..minutes of walking time.....

Distance to the nearest farmers group from residence (km)……..minutes of walking time.....

Distance to the nearest agricultural extension office from residence (km)……minutes of walking time…..

Are you a model farmer? [1=Yes, 0=No] _____

Codes A: 1. Oromifa. ; 2. Amharic., 3. Guragegna .; 4. Kembatagna; 5.Tigrigna; 6.Other.....

Codes B: 1. Yes, 0.No

Codes C:1. Burned bricks; 2. Unburned bricks; 3. Mud bricks; 4. Stone; 5. Earth; 6. Wooden (timber); 7. Wooden plastered with mud.

8. Other, specify……

Codes D: 1. Grass thatch; 2. Iron sheet; 3. Tiles; 4. Other, specify……

Codes E: 1. Food shortage through the year, 2. Occasional food shortage, 3. No food shortage but no surplus, 4. Food surplus.

Codes F: 1. Walking; 2. Bicycle; 3. Tractor; 4. Car; 5. Cart; 6. Other, specify……

Codes G: 1= Very poor; 2= Poor; 3= Average; 4=Good; 5= Very good

Appendix C: DCE choice sets

Welcome to the Farm Animal Welfare Choice Experiment Survey!
Thank you for agreeing to take part in this important survey. Your input is invaluable as it helps us understand preferences and decision-making processes in various scenarios.

1. Read each scenario carefully.
2. Consider the options presented and select the one that best fits your preference.
3. There are no right or wrong answers.

This survey should take approximately 10 minutes to complete. We appreciate your thoughtful responses and commitment to time.

Before we begin the choice scenarios, I want to stress the importance of providing realistic responses. Imagine that the choices and scenarios we present to you are real. These are about how these decisions would affect your daily life, your farm and your financial situation. Your honest and thoughtful responses are extremely valuable to us.

Choice Set 1:

Attributes	Alternative 1	Alternative 2	Opt-out
Animal Welfare Standards	Basic	Enhanced	Unchanged conditions and no payments
Financial Incentives	5% increase in sheep and goats' sales per year	10% increase in sheep and goats' sales per year	
Training and Support	Basic training in animal care	Advanced training in animal care	
Certification and Recognition	Participation certificate	Public recognition certificate	
Contract Length	1 year	2 years	
Community Involvement	Individual-based	Community-based	

Which option would you choose?

A. Alternative 1
B. Alternative 2
C. Opt-out

Choice Set 2:

Attributes	Alternative 1	Alternative 2	Opt-out
Animal Welfare Standards	Basic	Optimal	Unchanged conditions and no payments
Financial Incentives	10% increase in sheep and goats' sales per year	15% increase in sheep and goats' sales per year	
Training and Support	Advanced training in animal care	Basic training in animal care	
Certification and Recognition	Participation certificate	Public recognition certificate	
Contract Length	1 year	3 years	
Community Involvement	Community-based	Individual-based	

Which option would you choose?

A. Alternative 1
B. Alternative 2
C. Opt-out

Choice Set 3:

Attributes	Alternative 1	Alternative 2	Opt-out
Animal Welfare Standards	Basic	Enhanced	Unchanged conditions and no payments
Financial Incentives	5% increase in sheep and goats' sales per year	20% increase in sheep and goats' sales per year	
Training and Support	Advanced training in animal care	Basic training in animal care	
Certification and Recognition	Public recognition certificate	Participation certificate	
Contract Length	1 year	2 years	
Community Involvement	Individual-based	Community-based	

Which option would you choose?

A. Alternative 1
B. Alternative 2
C. Opt-out

Choice Set 4:

Attributes	Alternative 1	Alternative 2	Opt-out
Animal Welfare Standards	Basic	Optimal	Unchanged conditions and no payments
Financial Incentives	15% increase in sheep and goats' sales per year	10% increase in sheep and goats' sales per year	
Training and Support	Advanced training in animal care	Basic training in animal care	
Certification and Recognition	Participation certificate	Public recognition certificate	
Contract Length	2 years	1 year	
Community Involvement	Community-based	Individual-based	

Which option would you choose?

A. Alternative 1

B. Alternative 2
C. Opt-out

Choice Set 5:

Attributes	**Alternative 1**	**Alternative 2**	**Opt-out**
Animal Welfare Standards	Enhanced	Basic	Unchanged conditions and no payments
Financial Incentives	10% increase in sheep and goats' sales per year	5% increase in sheep and goats' sales per year	
Training and Support	Basic training in animal care	Advanced training in animal care	
Certification and Recognition	Public recognition certificate	Participation certificate	
Contract Length	3 years	1 year	
Community Involvement	Individual-based	Community-based	

Which option would you choose?

A. Alternative 1
B. Alternative 2
C. Opt-out

Choice Set 6:

Attributes	**Alternative 1**	**Alternative 2**	**Opt-out**
Animal Welfare Standards	Optimal	Enhanced	Unchanged conditions and no payments
Financial Incentives	20% increase in sheep and goats' sales per year	15% increase in sheep and goats' sales per year	
Training and Support	Basic training in animal care	Advanced training in animal care	
Certification and Recognition	Participation certificate	Public recognition certificate	
Contract Length	2 years	1 year	
Community Involvement	Community-based	Individual-based	

Which option would you choose?

A. Alternative 1
B. Alternative 2
C. Opt-out

Choice Set 7:

Attributes	Alternative 1	Alternative 2	Opt-out
Animal Welfare Standards	Basic	Enhanced	Unchanged conditions and no payments
Financial Incentives	5% increase in sheep and goats' sales per year	20% increase in sheep and goats' sales per year	
Training and Support	Advanced training in animal care	Basic training in animal care	
Certification and Recognition	Participation certificate	Public recognition certificate	
Contract Length	1 year	2 years	
Community Involvement	Individual-based	Community-based	

Which option would you choose?

A. Alternative 1
B. Alternative 2
C. Opt-out

Choice Set 8:

Attributes	Alternative 1	Alternative 2	Opt-out
Animal Welfare Standards	Basic	Optimal	Unchanged conditions and no payments
Financial Incentives	10% increase in sheep and goats' sales per year	5% increase in sheep and goats' sales per year	
Training and Support	Basic training in animal care	Advanced training in animal care	
Certification and Recognition	Public recognition certificate	Participation certificate	
Contract Length	3 years	1 year	
Community Involvement	Community-based	Individual-based	

Which option would you choose?

A. Alternative 1
B. Alternative 2
C. Opt-out

Choice Set 9:

Attributes	Alternative 1	Alternative 2	Opt-out
Animal Welfare Standards	Enhanced	Basic	Unchanged conditions and no payments
Financial Incentives	15% increase in sheep and goats' sales per year	10% increase in sheep and goats' sales per year	
Training and Support	Advanced training in animal care	Basic training in animal care	
Certification and Recognition	Public recognition certificate	Participation certificate	
Contract Length	2 years	1 year	
Community Involvement	Individual-based	Community-based	

Which option would you choose?

A. Alternative 1
B. Alternative 2
C. Opt-out

Choice Set 10:

Attributes	Alternative 1	Alternative 2	Opt-out
Animal Welfare Standards	Basic	Optimal	Unchanged conditions and no payments
Financial Incentives	5% increase in sheep and goats' sales per year	20% increase in sheep and goats' sales per year	
Training and Support	Basic training in animal care	Advanced training in animal care	
Certification and Recognition	Participation certificate	Public recognition certificate	
Contract Length	1 year	3 years	
Community Involvement	Community-based	Individual-based	

Which option would you choose?

A. Alternative 1

B. Alternative 2
C. Opt-out

Choice Set 11:

Attributes	**Alternative 1**	**Alternative 2**	**Opt-out**
Animal Welfare Standards	Optimal	Enhanced	Unchanged conditions and no payments
Financial Incentives	20% increase in sheep and goats' sales per year	10% increase in sheep and goats' sales per year	
Training and Support	Basic training in animal care	Basic training in animal care	
Certification and Recognition	Participation certificate	Participation certificate	
Contract Length	2 years	1 year	
Community Involvement	Community-based	Individual-based	

Which option would you choose?

A. Alternative 1
B. Alternative 2
C. Opt-out

Choice Set 12:

Attributes	**Alternative 1**	**Alternative 2**	**Opt-out**
Animal Welfare Standards	Enhanced	Basic	Unchanged conditions and no payments
Financial Incentives	10% increase in sheep and goats' sales per year	5% increase in sheep and goats' sales per year	
Training and Support	Enhanced training	Basic training	
Certification and Recognition	Certificate participation	Public recognition certificate	
Contract Length	2 years	3 years	
Community Involvement	Individual-based	Community-based	

Which option would you choose?

A. Alternative 1

B. Alternative 2
C. Opt-out

Thank you for taking part in our survey! Your responses are crucial to our research and will contribute significantly to our understanding of decision-making patterns.

What Happens Next?

Your responses will be analyzed along with others to ensure privacy and confidentiality. We may publish the results of this study; however, all data will be presented in aggregate form only. If you have any questions about the survey or our research, please do not hesitate to contact us. Thank you once again for your valuable input!

Appendix D: Survey tool traders' interview in three markets

Section 1: Demographic Information
Age: ____
Gender: Male / Female
Location: City/Town ____
Education level____
Years of experience in the livestock market: ____
6. What is your current role in the livestock market?

A. Farmer
B. Trader
C. Buyer
D. Supplier
E. Other: _____ (allow for open response)

Section 2: Transport to the Market

No	Breed	Number of animals
1	Sheep	
2	Goats	

How long does the transport of sheep and goats typically last from the original place?

a. Less than 1 hour
b. 1-3 hours
c. 4-6 hours
d. More than 6 hours

How often are sheep and goats transported to the market?

a. Daily
b. Weekly
c. Monthly
d. Seasonally

What method of transport is primarily used for sheep and goats?

a. Lorry truck
b. Horse cart
c. On foot

d. Other _____

Which of the following best describes the transport conditions for sheep and goats?

a. Well-ventilated and spacious
b. Adequately ventilated but crowded.
c. Poor ventilation and very crowded
d. Exposed to the elements with no protection.

Have you seen stress or discomfort in sheep and goats during transport?

a. Yes, often!
b. Yes, occasionally!
c. Rarely
d. No

How did you get them?
1. from original farm ____
2. from other markets ____

Health and Welfare Measures: What welfare measures are provided during transport?

No	Provision of ----during transport	Yes	No
1.	Rest		
2.	Shelter		
3.	Water		
4.	Feed		

How many animals died during transport? _____, why?
1. Traffic accident ___
2. Bad condition ___
3. Other ___ What? _____
How many of them got injured/ sick? _____
During transporting animals to the market what do you consider the main Problem?
1. _____
2. _____
3. _____
4. _____
5. _____

Section 3. At Market

Name of Market: _____
Breed & number of animals can be marketed at a specific time

No	Breed(species)	Number of animals
1.	Sheep	
2.	goat	

Animal condition:
1. Thin ___ can see ribs clear, obviously spinal column
2. Normal ___ can see ribs and spinal columns, not clear

3. Fat ___ cannot see ribs or spinal column
Injury
1. Dead ___
2. Lameness ___
3. Opened, bleeding cut ___
4. Other injury ___ what?

_____
Are injured/sick animals treated?
1. Yes ___
2. No ___
Is there a provision for the following management activities at the market?

No	Provision of the following at Market	Yes	No
1.	Rest		
2.	Shelter		
3.	Water		
4.	Feed		

Which of the following is a key principle of humane animal handling?

a. Using loud noises to move animals quickly

b. Applying minimal stress techniques for movement

c. Keeping animals isolated from each other

d. Moving animals as quickly as possible regardless of conditions

What is the practice for loading animals onto transport vehicles?

a. Using force and pressure to load animals quickly

b. Ensuring animals are loaded calmly and with care to avoid stress

c. Loading animals without any pre-transport rest

d. Loading animals in mixed groups unfamiliar with each other

Upon arrival at the destination, how should animals be unloaded?

e. Quickly to minimize transport costs

f. Calmly and carefully, allowing animals to adjust to their new surroundings

g. Without providing water or rest immediately after unloading

h. Using the same methods as loading regardless of animal stress levels

Why is it important to be aware of animal behavior during loading and unloading?"

i. To ensure the process is completed as quickly as possible

j. To minimize stress and potential injury to the animals

k. Behavior does not significantly impact the loading/unloading process

l. To make the process easier for handlers, regardless of animal welfare

What do you consider the main problem?

1. _____
2. _____
3. _____
4. _____
5. _____

Appendix E: Human-wildlife conflict household Survey

Part1. Livestock production activities during the 2023 cropping year

Livestock type	Number of livestock owned at the time of survey	
	Owned	Shared
Cattle		
1. Indigenous milking cows		
2. Cross-bred milking cows		
4. Non milking cows (mature)		
5. Trained oxen for Ploughing		
6. Bulls		
7. Heifers		
8. Calves		
Goats		
9. Mature female goats		
10. Mature male goats		
11. Young male goats		
12. Young female goats		
Sheep		
13. Mature female sheep		
14. Mature male sheep		
15. Young female sheep		
16. Young male sheep		
Other livestock		
17. Young donkeys		
18. Horses		
19. Mules		
20. Mature chicken		

Income from livestock sales during the last six months_____ Birr

Part 2. Detail research questions about livestock depredation

1. Do you agree on the presence of livestock predators in this area?
   A. Yes
   B. No

2. What are the major predators spotted in this area for the last three years?
3. Which livestock types are the major target of the predators?
   A. cattle
   B. sheep
   C. goat
   D. donkey
   E. hens
4. How many livestock were predated within the last five years?

Species	**No of deaths**
cattle	
sheep	
goat	
donkey	
hens	

5. List causes of Mortality for the livestock for the last 5 years.

Types of the livestock	Number and Cause of Mortality			
	Predator	Disease	Accident	missing
Cattle				
Sheep				
Goat				
Donkey				
Hens				

6. What is the estimated cost of livestock's killed by predators during the last past five years?

Species	**Cost estimated**
cattle	
sheep	
goat	
donkey	
hens	

7. What are the major causes of livestock predation?
   a. Human settlement
   b. Agricultural practices
   c. Overgrazing
   d. Deforestation for charcoal or other purposes
   e. Deliberate fire to free lands

8. Types of species (wild animals) that created different levels of danger for the household?

species	no problem	small problem	big problem
Lion			
Leopard			
spotted hyena			
striped hyena			
Cheetah			
wild dog			
Jackal			
Felis serval			
Wildcat			
Crocodile			
Monkey			
Buffalo			

9. Do you guard your livestock from predators during the daytime?
   a. Yes

b. No
If yes, how do you do that?
If no, why?

10. How do you keep your livestock's during the nighttime?
    a. By placing them in a tin house
    b. By placing them in grass house

11. What other additional strategies do you use to keep livestock from the danger of predators?
    a. strengthening collars or houses to prevent penetration
    b. moving around collars with torches
    c. using stones and traditional weapons
    d. using guard dogs

12. Are you using poison or trap to control carnivores' attacks in and around the park**?**
    a. Yes
    b. No
    If not,

Reasons for not using poisons or traps	**Number of people**
Don't have it	
I don't know how to use it	
Due to the prohibition by the government	
I think that it is wrong	
Too expensive	
Use of other methods	
Threat to domestic animals	

13. Did predators attack humans in and around the Nech Sar park within the last five years?
    a. Yes
    b. No
    If yes, how many and how often?

14. Did you suffer from crop damage to wildlife?
    a. Yes
    b. No
    if yes, what type of crops are mostly affected?

15. What measures did you take to protect your crops from wildlife?

16. Is the number of attacks by predators higher at specific season (time) of the year?
    a. Yes
    b. No
    If yes, why do you think is the reason for this

17. if predators kill your livestock, how do you respond?
    a. Let it feed it, the poor animal must be hungry.
    b. I can do nothing; I can bear to lose 1-2 animals occasionally.
    c. I do not know what to do.
    d. I will chase it away.

e. I will kill the animal if the law permits it.

18. List the various traditional guarding measures you use in reducing or controlling livestock loss through predators.
19. Rank the above listed traditional guarding measures in reducing or controlling livestock loss.
    a. Very ineffective
    b. Ineffective
    c. Effective
    d. Very effective
20. Do you agree with the rules and regulations of Nech Sar Park in how it deals with the predators?
    a. Yes
    b. No
    If no, why?
21. Do you agree if the government cover 30% of the cost of building modern pen(housing) for your livestock?
    a. Yes
    b. No
    If not, why?
22. Did you receive compensation in any form (subsidies, food aid etc) from the government for the loss of your livestock?

    a. Yes

    b. No

23. Are you confident of the skills of government officials including extension workers to do their job?

    1. strongly disagree; 2. Disagree; 3. slightly disagree; 4. slightly agree; 5. Agree.
    6. Strongly agree