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The Impact of Camel Transportation on the Livelihood of Pastoralists: In Berahle Woreda, Afar Regional State of Ethiopia

BY:

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Mekelle, Ethiopia

DECLARATION

I, the undersigned, declare that this thesis entitled ***"The Impact of Camel Transportation on the Livelihood of Pastoralists: In Berahle Woreda, Afar Regional State of Ethiopia",*** submitted to department of economics, college of business and economics, Mekelle University is my authentic work. All the sources that I have used in this project work have been acknowledged and indicated as a reference. I solemnly declare that this thesis is my own work and has not submitted earlier to any other institution anywhere for the award of any other degree, diploma or certificate.

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CERTIFICATION

This is to certify that this thesis entitled ***"The Impact of Camel Transportation on the Livelihood of Pastoralists: In Berahle Woreda, Afar Regional State of Ethiopia"*** is an authentic work of Ms. Selamawit Teklu who carried out the research under my guidance. Furthermore, to the best of my knowledge the work reported here does not form part of any project report or thesis on the basis of which a degree or award was conferred on an earlier occasion on this or any candidate. Hence, I recommend that it be submitted as fulfilling a thesis requirement.

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ABSTRACT

The main objective of this study was to assess the impact of camel salt transportation service on the livelihood of pastoralists in Berahle woreda, Afar regional state of Ethiopia. A cross sectional primary data of 250 sample households (including 115 camel owners and 135 camel non-owners) was used for analysis. Propensity score matching (PSM) method was implemented to capture the livelihood contribution of camel salt transportation service for the camel owner pastoral households in the study area. Four matching algorithms (Nearest-Neighbour, Kernel, Radius and Stratification) were used for estimation and their result was consistent which shows their robustness. Income, livestock ownership and fixed asset formation of the households were used as livelihood indicators to compare the livelihood differences between the camel owner and non-owner households. Accordingly, a positive and significant difference was found in two of the livelihood indicators i.e., income and livestock ownership, but not fixed asset holdings between the two groups of households. The paper has also tried to identify the main determinant factors influencing the camel rent decision of the camel owner pastoral households using ordered probit regression model. The result reveals that, literacy of the household head and number of camels owned by the household are the factors affecting household head's decision to rent out his/her camels for other salt transporters or not. Another focus of the study was, identifying the main beneficiaries of the salt mine among the salt trade value chain participants and calculating the profit percentage share of the salt transporters, using descriptive statistics. Based on the analysis, the salt transporters were found to be the main beneficiaries among the salt trade value chain participants.

Keywords:- *Camel, Transportation, Livelihood, Propensity Score Matching (PSM), Camel Rent Decision, Ordered Probit, Profit*

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ACRONYMS AND ABREVIATIONS

AE	Adult Equivalence
ATT	Average Treatment Effect for the Treated
CIA	Conditional Independence Assumption
COMESA	Common Market for Eastern and Southern Africa
CSA	Central Statistical Authority
E.C.	Ethiopian Calendar
EDH	Ethiopian Demography and Health
ETB	Ethiopian Birr
FAO	Food and Agriculture Organization of United Nations
FDRE	Federal Democratic Republic of Ethiopia
FGD	Focus Group Discussion
GDP	Gross Domestic Product
HH	Household
Kg	Kilogram
KM	Kernel Matching
LPPS	Lokhit Pashu-Palak Sansthan (is “Pastoralist Welfare Institute”)
MLM	Maximum Likelihood Estimation Method
NNM	Nearest Neighbour Matching
PS	Propensity Score
PSM	Propensity Score Matching
RM	Radius Matching
SM	Stratification Matching
TLU	Tropical Livestock Unit

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CHAPTER ONE

1. INTRODUCTION

1.1Background of the Study

Pastoralism, also known as animal husbandry, is a social and economic system practiced by people dwelling in arid and semi-arid environments in which raising and herding of livestock such as camels, goats, cattle, and sheep using mainly traditional knowledge is the primary economic activity of the society.

Pastoral production systems are those "in which at least 50 percent of the gross incomes of households (i.e. the value of market production and the estimated value of subsistence production consumed by households) come from pastoralism or its related activities, or else, where more than 15 percent of households' food energy consumption involves the milk or dairy products they produce" (Swift, 1988).

In Africa, particularly in the arid and semi-arid lands of the Horn and East Africa, pastoralism is one of the oldest, most resilient and most adaptive livelihood system practiced by millions of peoples. The pastoral lands, in which these pastoralists reside, cannot support sustained and reliable agriculture because of the extreme variability in time and place of weather patterns i.e. rain. These difficulties make pastoralism to have a mobile aspect, moving the herds in search of fresh pasture and water (in contrast to pastoral farming, in which non-nomadic farmers grow crops and improve pastures for their livestock). Pastoral households use climatic variability to their advantage to maximize the productivity of their herds by livestock mobility and selective breeding of animals without degrading the environment in the rangelands (COMESA, 2009).

In Ethiopia, pastoral and agro pastoral areas cover about 61 percent of the country's land mass on which over 12 million people are living. These areas are characterized by their poor infrastructural development and the highest incidence of poverty and household food insecurity. The number of livestock, which is the main resource base for the pastoral households, continues to decline due to recurrent droughts, animal diseases and conflicts (FDRE Ministry of Federal Affairs, 2008).

Ethiopia has the largest number of domestic livestock in Africa and much of it originates from the country‘s pastoral zones. These areas contain approximately 30 percent of the national population or 9.3 million cattle, 52 percent or 12.4 million sheep, 45 percent or 8.1 million goats and close to 100 percent or 1.8 million camels (Catley, 2009). This livestock population contributes 15 to17 percent of the country’s GDP and 35 to 49 percent of agricultural GDP, and 37 to 87 percent of the household incomes (Sintayehu *et al.*, 2010). In these pastoral zones, camel is a primary stock and is highly valued.

Camel is a large and strong animal of the desert and it is one of the powerful transportation animals. It can go in such area where transportation vehicle can’t go and carry people and heavy loads to the places where there are no roads. Furthermore, it is the camel's ability to withstand extreme temperatures and harsh conditions. It can flourish where no other domestic animal can survive which make it so valuable in arid and hot conditions during the day and cold temperatures at night. In times of water scarcity, it can endure without water for more than two weeks. It is generally used as pack animal and not so much as a free ride. Camel is universally highly valued and provides social standing for its owner.

Afar region[1] is one of the four major pastoral regional states in Ethiopia located in north eastern part of the country. It is a region in which its all woredas are pastoral woredas. The Afar pastoralists raise mixed species of primary livestock, usually camels and cattle, and keep supplementary herds of goats and sheep.

Similar to the country’s general context, camel is also best suited to the arid desert areas of Afar region. It is a primary stock and status indicator and represent the nomadic capital wealth of the Afar society and is essentially raised and kept for this reason (Guinand, 2000).

According to Sintayehu *et al.* (2010), Afar region constitutes about 22.5 percent of the total camel population of the country.

[1] The short notation “Afar region” is used to represent “Afar Regional State of Ethiopia” throughout the paper.

1.2 Statement of the Problem

Livestock has an economic and social importance both at national and international levels particularly in pastoral areas. Animals assist humans in carrying out different tasks in agriculture, transport, irrigation, building industry, etc. In transportation, they are used for pulling carts and loads over a surface, logging and carrying loads as pack animals (Simalenga and Joubert, 1997).

According to FAO report (n.d), in many parts of the world, rural trade is assisted through animal-powered transport (on farm, marketing, riding, pack transport). Animals save household (particularly women and children) time and effort by carrying water and fuel wood. Animal power can also be used for water-lifting, milling, logging and land excavation and road construction. To carry out these tasks, many different types of animals are employed, particularly cattle (oxen, bulls and cows), camels, buffaloes, mules, donkeys and horses.

Farmers with animal transport (carts or pack animals) have wider contacts with traders. The resulting enhanced market access allows them to increase their production and also their profit. With animal transport, greater use is made of manure and crop residues, which increases overall farm production. Animal power can provide important local `feeder' transport between farms and roads, to complement motorized road transport systems. The development of efficient animal-based transport is often constrained by limited supplies of carts and capital or credit for acquisition. However, animal-based transport is usually very profitable (Ibid).

Camels, known as "ships of the desert", are the only desert animals those can carry heavy loads of goods and travel for a long period of time without food or water. They can carry loads weighing 150–300 kg over long distances and 450 kg over short distances and are convenient in times of water scarcity to travel in dry lands (Heanving and Zhongmin, n.d).

Camels have social and economic benefit for their owners. Millions of people who live in Africa depend on camels to supply most of their needs. In lands at the edge of the deserts, camels pull ploughs, turn water wheels to irrigate fields and carry grain to market places. Deep in the deserts, camels are almost the only source of transportation, food, clothing, and shelter (Farah and Fischer, 2004). In addition, according to Schwartz (1988), during the recent famines in the vast dry areas in Africa, camels were frequently used to carry relief food to remote, otherwise inaccessible locations.

Nowadays, traditional modes of transportation are diminishing their use and their importance due to technological advancement and the role of pack animals transportation is substituting by the motorized means of transportation. But, even if pack animals transportation is substituting by modern means of transportation, in many countries of the world particularly in the LDCs still it is important means of transportation.

Particularly in Ethiopia, despite the introduction of a motorized transportation, animal power particularly camels remain an important means of transportation by providing a cheap and reliable alternative for short, medium and long distance transport of many kinds of goods such as grain, salt, domestic water and fuel, household tools and animal feed in the arid and semi-arid regions of the country.

Camel in Ethiopia has multiple uses. It serves as a:

- Source of income
- Means of transportation
- Source of food by providing milk and meat for household consumption
- Lifting of water and
- Powering of oil mills

In Afar region, camel has a unique function than in any other regions of the country i.e., it is useful to transport salt, which is one of the major minerals found in the region, from its source where it is extracted to the market where it is sold. This salt trade using camels is one of the means of income generation for the camel owner pastoralists in the area and others participating in the trade chain of the salt. Hence, among the transportation services that a camel provides to the pastoralists, the researcher's main concern is its service in transporting salt from the mining area to market place.

Even if camel is the main means of transporting salt that the salt transporters use in the study area, still there is no as such well documented empirical study which explores the economic contribution of the camel salt transportation service in general and its impact on the livelihoods of the camel owners in particular, though it is an issue which demands a due concern.

This gap motivates the researcher to put some effort and fill this information gap by investigating the factors those determine camel ownership of households, the impact of camel salt transportation service on the livelihoods of the camel owner pastoral households and the profit proportion of the salt transporters out of the total profit of the salt trade value chain participants in Berahle woreda of Afar region which is untouched area.

1.3 Research Questions

The research was attempted to answer the following questions:

- What are the determinant factors those affect households' camel ownership in the study area?
- Does camel salt transportation service has an impact on the livelihoods of the camel owner pastoral households?
- What are the factors behind, which affect the camel owner pastoral households' camel rent decision (whether to rent out their camels for other salt transporters or to transport salt by themselves)?
- How much is the profit proportion of the salt transporters from the salt mine among the salt trade value chain participants?

1.4 Objectives of the Study

1.4.1 General Objective

The overall objective of the study was to assess the impact of camel salt transportation service on the livelihoods of pastoralists in Berahle woreda, Afar regional state of Ethiopia.

1.4.2 Specific Objectives

This study has tried to address the following specific objectives.

- To identify the determinant factors those affect households' camel ownership in the study area.
- To assess the impact of camel salt transportation service on the livelihood of pastoralists by comparing the livelihood of camel owner pastoral households with non-owner households using propensity score matching.
- To investigate the factors behind camel owner pastoral households' camel rent decision (whether to rent out their camels for other salt transporters or transport salt by themselves).
- To calculate the profit percentage share of the salt transporters out of the total profit of the salt trade value chain participants.

1.5 Significance of the Study

Most of pastoral households in Afar region are highly dependent on livestock production, particularly camel, for their livelihoods. For these pastoralists, camel has multiple uses: it serves as a means of income generation, means of transportation, and source of milk and meat for household consumption. In the region, particularly in Berahle woreda, camels are almost the only means of transporting salt, food, clothing and shelter. But still there is a misperception and a lack of understanding among people about the economic contribution and significance of the camel transportation service.

Since one of the major objectives of the country is to achieve an economic growth to be one of the middle income countries and pastoralism is part of the country's economy, the government is giving a heavy emphasis to promote a positive view of pastoral economies and development to counter the very strong under-appreciation of the economic contributions of pastoralism.

Thus, it is believed that, valuation of the impact of camel salt transportation service on the livelihoods of the camel owner pastoralists is important for better understanding of economic contribution and importance of camel transportation service.

This study is expected to be an important input for policy makers on how to make pastoralism in general and camel transportation service in particular as a positive contributor to economic growth and development. Confidently, it will also be an important ingredient in paving the way for researchers who have the interest to conduct a research in this area.

Generally, this research is significant for policy makers, researchers and government organizations.

1.6 Scope of the Study

Out of the different transportation services that a camel provides to its owners in the study area, only its role in transporting salt is analyzed in this study. However, it was also probably better to value its transportation service in transporting other goods such as domestic water and fuel, household tools when the nomadic residents around the study area move from one area of residence to other, and so on.

In addition, even if pastoral households of different parts of the region and non-pastoral individuals who came from different regions of the country are beneficiaries of this camel salt transportation service, the researcher tried to investigate its impact on the livelihoods of pastoralists of one woreda of the region, Berahle woreda, only which is selected as a sample representative of the region. However, it is supposed that, it was important to value its transportation service in other woredas of the region and in other regions and even at national level.

To avoid that the study could become too general and so as to make it manageable and feasible, it was decided to conduct an intensive investigation within these delimitations.

1.7 Limitations of the Study

Basically, the survey was conducted at one single point in time providing a cross sectional data; hence, individual changes through time are not available. Moreover, the survey was undertaken taking one woreda as a representative in which it has to be recognized that the findings of the study regarding the economic contribution of camel transportation service may not be generalized beyond the boundaries of the study area even for the other woredas of the region and other pastoral regions of the country with similar camel owner pastoral households. The response of the sample households and FGDs may not also be free from personal bias. However, given all these limitations, considerable care was taken in making the study as objective and systematic as possible.

1.8 Organization of the Study

The paper is framed in five chapters. The first chapter incorporates background of the study, statement of the problem, objectives of the study, scope of the study, significance of the study and limitations of the study. The second chapter presents the review of related literatures that includes both theoretical and empirical literatures. The third and the fourth chapters also present methodology of the study and data analysis and presentation of results respectively. In the fourth chapter, the raw data is analyzed via both descriptive and econometric methods of data analysis. The fifth chapter presents the conclusions and policy recommendations.

CHAPTER TWO

2. LITERATURE REVIEW

This chapter has two parts: the theoretical review and the review of empirical literatures. The first part briefly discusses about the theoretical perspectives with a subject matter related to the benefits of animal traction particularly camel transportation service, challenges to camel production and causes of camel loss. The second part emphasizes on giving general information on how to use PSM method on livelihood impact assessment of livestock production and what factors determine livestock ownership by reviewing related literatures undertaken on livelihood contribution of livestock.

2.1 Theoretical Review

In this part, review of literatures carried out in areas related to the general benefits of animal traction, particularly the benefits of camel and its transportation services are presented.

2.1.1 Terminology and Definitions

Livelihoods: - Livelihoods involve the use of assets in activities to produce outputs to enable them meet consumption requirements and aspirations and also to invest assets and activities for the future. This commonly takes place in the context of an uncertain environment. For instance, for the pastoral households, keeping livestock may help them to meet their consumption requirements not only by directly providing them with food, fuel, transport, or with hair or wool for clothing, but also by generating sales income that helps them to purchase these and other consumption goods and services (LPPS, 2005).

Pastoralism: - Is a livelihood and production system practiced by peoples who live in arid and semi-arid environments. The main activity of pastoral peoples is raising and herding of livestock such as camels, sheep, goats, cows, etc. Most of the land in which pastoralists reside cannot support sustained and reliable agriculture because of the extreme variability of weather patterns that it faces. Due to this factor, pastoralism has a mobile aspect, moving the herds in search of fresh pasture and water.

Livestock: - Is an umbrella term used for domesticated animals raised usually in an agricultural environment with the intent of providing food, textiles, labor, or fertilizer to their

owners. Animals like horses, pigs, goats, cows, sheep, camels and poultry are considered livestock (McMahon, 2013).

Tropical Livestock Units (TLU): - The equivalence between different species is often expressed in terms of TLU. A TLU is 250 kilograms live weight of any domestic herbivore (Sandford, 2006).

Animal traction: - is the human use of non-human working animals [cattle (bulls, oxen and cows), donkeys, mules, horses, goats, camels, etc.], to assist humans in carrying out different tasks in agriculture, transport, irrigation, building industry, etc. In transportation, they are used for pulling carts and loads over a surface, logging and carrying loads as pack animals (Simalenga and Joubert, 1997).

Pack transportation: - is transporting loads on the backs of animals which provide a reasonably rapid, quiet, and reliable mobility even in mountains, jungles, and other terrain which are unsuitable for vehicular transportation.

Camel: - Camels are ungulates and are herbivores. There are two species of camels: Dromedary camels and Bactrian camels. A Bactrian camel has two humps and a Dromedary Camel has one visible hump which is a distinctive fatty deposit on their back. The dromedary camel is native to the Middle East and the Horn of Africa and the Bactrian camel is inhabit in Central Asia.

Camel is a large and strong hard working animal of the desert. It can travel a great distance with little food and water across hot and dry desert where transportation vehicle can’t go and carry people and heavy loads to the places where there are no roads. The average life expectancy of a camel is 40 to 50 years. A full-grown adult camel stands 1.85 m at the shoulder and 2.15 m at the hump. Camels can run at speeds of up to 65 km/h (40 mph) in short bursts and sustain speeds of up to 40 km/h (25 mph) in long distances. Camels are able to withstand changes in body temperature and water consumption that would kill most other animals.

Camel train: - Is a series of camels carrying goods or passengers or both in a group as part of a regular or semi-regular service between two points.

2.1.2 Animal Traction and Its Benefits

Different authors have written about the general economic and social benefits of animal traction to the national economy in general and to pastoral households in particular. Some of the related literatures reviewed in this study are presented below.

According to Heffernan *et al.* (2001), for many poor households, livestock is the primary form of savings. As an investment, few other resources can match livestock as a means of capital growth. Animal sales may allow poor households to generate cash quickly during times of need. Moreover, livestock, including manure, is often a key source of income. Livestock is also social capital. It is important in supporting social relationships. Loans and gifts of livestock contribute to bonding, bridging and linking in social capital relationships, and livestock is one means by which family and household social capital may be measured.

Similar study conducted by Nkala (2012) in central Mozambique has also stated the wide range contribution of animals to social and economic wellbeing of peoples. Nkala reported that, livestock together with crop production, comprises the main source of income for the agro-pastoralists in the study area. The agro-pastoral households in the area did raise different types of livestock in different combinations - cattle, sheep and goats or camels, goats and sheep or all. Cattle and sheep are primarily grazers, while camel and goats are normally browsers. Cattle production dominated in agro-pastoral livestock production. As pasture condition deteriorated over the years, agro-pastoral communities shifted from fewer cattle to more camel production with shoats to sustain subsistent households' income.

Animals assist in eliminating poverty, reducing drudgery and creation of wealth. Animal traction is particularly important for food security in smallholder farming systems. Animals save household (especially women and children) time and effort by carrying water and fuel wood (FAO, n.d).

Animal power is a renewable energy source that is particularly suited to family-level farming and to local transport. Animal power is generally affordable and accessible to the smallholder farmers, who are responsible for much of the world's food production. The availability of animal power allows women and men to increase their efficiency and reduce their drudgery, compared with manual alternatives. The transport role of animals is important for carrying farm inputs and outputs. Pack animals and carts facilitate the marketing of produce, stimulating local trade and production. Furthermore, animals can be very important for carrying domestic

water and fuel, releasing time that can be used in other productive or socially important tasks. Even if motorized power also brings many benefits, animal power is normally more available and affordable to people in rural areas and fragile environments (Ibid).

The idea of the study conducted by Starkey and Fernando (1998) is also in line with this. Transport systems based on animal energy can have several social and economic benefits for women and communities. The tiring and time consuming women's tasks of transporting water, fuel wood and grains for milling can be greatly relieved using animal energy. If animals are available, women may be able to delegate water collection to children. The woman gains important time, while children often find driving an animal-drawn cart as much a recreation as a household duty. Women's trade and marketing, which is a very important for the rural economy as a whole and their domestic economy in particular, has been restricted by their capacity to 'head-load' goods in many circumstances.

Moreover, Starkey and Fernando (1998), has also reported that, farmers with animal transport (carts or pack animals) have larger circles of contacts and trade which allows them to increase their production and their profit. Using animal energy for transport, greater use is made of manure and crop residues, which also increases overall farm production. As women farmers and traders are freed from the limitations of head-loading, more is produced and traded, increasing profits and overall economic activity.

This indicates that, pack animals offer a significant payload advantage over human carriage, especially if one person can command the use of several animals. Even with a single animal, the potential cost reduction from substitution of pack for human carriage is of the order of 50 percent, which would significantly improve the efficiency of transport work by farmers (Tesfahunegn, 1986).

Importance of animals as a means of transportation has to be considered starting from the time in which there was no any developed modern means of transportation. Because transportation is important for human existence and it is obvious that, in those times, peoples do use their animals where no other alternative modern means of transportation was available.

Regarding this pre modernization contribution of animals, McMahon (2013) has written that:

> *"Before the time when we could hop on a plane for a few hours to get to the other side of the world or take a quick drive to the store, humans relied on animal-based transportation. For all of human existence,*

transportation has been of the utmost importance. From the transport of a nomadic community across barren lands to the current import of oil to America, human societies have always been forced to devise ways to move items from one place to another. It seems only natural that in a landscape so full of biodiversity, early humans would have turned to animals as a form of transportation."

However, even if animal transportation service has all the said economic and social importance, relying on such kind of forms of transportation has also its own negative consequences.

Reliance on traditional forms of transportation poses a considerable barrier to the development of an exchange economy and locks the peasant farmer into a subsistence mode of existence and low quality of life from which it is difficult to escape (Howe and Garba, n.d).

It is obvious that, animal power is an old technology. However, since animals are convenient to be used complementarily with other power sources, the increased use of tractors and motorized vehicles for transport can even be associated with an increased use of animals, as the overall rural economy grows and diversifies (FAO, n.d).

Regarding the continuity of animal traction, Simalenga and Joubert (1997) has predicted that, animal traction continues to increase in many parts of the world, particularly those where there are significant numbers of smallholder farmers. It will continue to be important for food security, self-reliance and poverty alleviation. All countries, whatever their degree of industrialization and urbanization, can benefit from ecologically sustainable power sources. Domestic animals can play a valuable role in assisting human endeavors and improving the quality of life of women, men and children.

2.1.3 Camels and Their Transportation Service

Camels are known as "ships of the desert" and have been used for transporting goods across deserts for thousands of years. In fact, camels are the only desert animals those can carry heavy loads of goods and travel for a long period of time without food or water. Transportation, however, is not the only benefit that camels can offer us. Desert peoples also rely on camels for their milk, meat, and fur. Even camels' droppings are useful; desert peoples use camels' manure as fuel.

In pastoral production systems of east Africa, camels are used as multifunctional animals and are kept for the aim of producing: milk, meat, blood, hides and skins, provision of transport, barter trade of sale and exchange, and social and cultural functions (Kaufman and Binder, 2002).

Camels provide a cheap and reliable alternative for short distance transport. Many kinds of goods are regularly transported over short and medium distances whatever the volume or value of trade is too low to make motorized transport feasible, and where roads are bad or non-existent. During the recent famines in the vast dry areas in Africa, camels were frequently used to carry relief food to remote, otherwise inaccessible locations (Schwartz, 1988).

Heanving and Zhongmin (n.d) in their study about "Camel trains in the desert" have written that, in the Thar Desert, camel carts are still popular and remain a frequent means of transportation. They fulfill this function not only in remote rural areas, but also in the major cities. They move goods of all kinds, especially wood, fodder, gas cylinders, fabrics, bricks, etc. Ownership of a camel and a cart is a solid source of income, sufficient to support a family. Camel can carry loads weighing 150–300 kg over long distances and 450 kg over short distances. Other chores performed by camel include threshing, lifting of water and powering of oil mills.

In the past two thousand years, caravans on the silk Road transported silk, tea, pottery and lacquer ware from China to the western regions; and pearls, jade, herbal medicines and perfume from Central and West Asia and Europe to China using camels. Peasants in Minqin County raise camels in their spare time. In summer, they milk camels and collect camel hair; and in autumn, they earn money by using camels to transport goods. Camels are loyal companions and guides to desert travellers. Therefore, those who raise camels look after them well as they depend on them for survival at times (Ibid).

Study by Srivastava (1991) in Rajasthan shows the value that is given to camel by the society. He states that, camel is often regarded as emblematic of Rajasthan. In Rajasthan folklore it symbolizes love, and ownership of a camel once signaled status and wealth. It was used for warfare by the Maharajahs and played an important role in desert communication, transportation and trade. Historically, camels were thus a valuable commodity used by the ruling classes and by the business community.

Coming to Ethiopian case, Eyassu (2009) in his *"Analysis of the Contributions of the Dromedary Camel and Constraints to Camel Production in Jijiga and Shinile Zones of Eastern Ethiopia"* reported that, dromedary camels play an important role to the livelihood and survival of nomadic pastoralists in the study areas. He found the main contributions rendered by dromedary camels in the study areas to be milk production and transportation. The major transportation services, that a camel render to the pastoralists, is transporting of people, goods and mobile houses during their seasonal migration. In the study areas, camels are often hired as a cargo to transport goods; particularly male camels are used as a draft animal for transportation of goods and people. But camels in these areas feed mainly on poor-quality natural vegetation.

Other related studies such as *"The camel in Eritrea: an all-purpose animal"* by Gebrehiwet (1998) review the overall role of camel in general and camel as a pack animal in particular. He reported that, in view of lack of roads and transportation facilities and the inaccessible terrain in most pastoral areas, the role of camel as a pack animal is crucial and determines the survival of the nomads in the hostile environments of the desert.

Then, due to all these valuable contributions that camels render, promoting camel husbandry is expected to improve livelihood of camel producing pastoral households. For instance, according to Houten (2002), promoting camel husbandry has improved food security for many pastoralists. One of the most significant aspects is how camel husbandry and production have now been taken up by many hundreds of pastoralists in his study areas, Samburu and Maasai. Although they herd their camels in a different manner, their herd productivity is often much higher than that of traditional camel owners.

Nowadays, modern transportation is expanding which seems to replace the traditional means of transportation. However, regardless of the introduction of motorized transportation, camels remain an important means of transportation in the arid and semi-arid regions. Apart from use by nomads who are continuously seeking grazing and water, these animals are employed in transporting farm produce to local markets (Katsina, 1990).

Hassan and Ibitoye (n.d) have also made similar conclusions about continuity of camels as a means of transportation. They predicted that, camels will continue to play active roles in the transportation of farm inputs and produce for short distance travels due to the rising costs of motor vehicles and spare parts.

2.1.4 Challenges to Camel Production and Causes of Camel Loss

Despite the benefits that African pastoralists get by producing camels, their camels are vulnerable to different challenges such as camel diseases, drought, rustling and predation which expose the pastoralists to risks of losing their camels which are source of their livelihoods.

For instance, Njuki *et al*., (2011) has stated the major challenges associated with camel production in the pastoral areas of east Africa to be predation, drought and camel diseases.

Drought, as a major challenge to camel production, can be attributed to loss of pasture and drying up of water sources during dry periods which results in the camels suffering from dehydration and starvation and eventually they would die. It may also lead to encroachment of wildlife protected areas leading to increased camel predation especially at the grazing fields and watering points (Onono *et al.*, 2010).

Similarly, Eyassu (2009) has also found the major constraints associated with camel production in his study areas to be feed shortage and prevalence of disease. Furthermore, he stated that, as a consequence of these problems, camels in the study areas feed exclusively on unimproved perennial natural vegetation of low nutritive value and they are not given supplementary feed.

2.2 Empirical Review

Propensity score matching (PSM) method is used to assess the impact of a particular treatment or intervention on outcome variables of interest. Particularly, while analyzing the livelihood impact of livestock production using cross sectional data, PSM is the appropriate method that has to be employed.

This part was intended to present review of an impact assessments undertaken by different authors on the livelihood contribution of livestock production in general and animal traction in particular using PSM method of data analysis. It would be better, if literatures which explore the livelihood contribution of livestock, analyzed using PSM method of analysis were reviewed. However, for a variety of reasons, there are no as such documented literatures in this area. Therefore, due to the absence of such empirical literatures, the only livestock related literature reviewed in this study is presented below.

Birol *et al.* (2010) has tried to investigate the role of poultry on the livelihoods portfolios of households and the impact of supply and demand shocks that may be caused by Highly Pathogenic Avian Influenza (HPAI) on various livelihoods outcomes of households in four Sub-Saharan African (SSA) countries; Ethiopia, Kenya, Ghana and Nigeria. They use probit model and zero inflated negative binomial model to profile the household, farm and regional characteristics of those households who are most likely to keep poultry, and those who are most likely to be engaged in intensive poultry production, i.e., keep larger household flocks and estimate the impact of the disease outbreaks and threats on livelihood outcomes by using propensity score matching. From their estimation results they revealed that, across the four SSA countries, the profiles of households who are predicted to be poultry keepers and those who are predicted to keep “larger” small-scale flocks have older and less educated household heads, and are larger with more children and with more adult women. In terms of asset ownership, households who are predicted to be poultry keepers and those who are predicted to keep “larger” flocks have higher average values of livestock wealth and other assets (e.g., land). Moreover, the result of the impact assessment reveals that, across the all four study countries, households which are “larger” small-scale producers seem to be most vulnerable to HPAI related shocks in terms of livestock income and/or wealth (asset value) loss.

CHAPTER THREE

3. METHODOLOGY OF THE STUDY

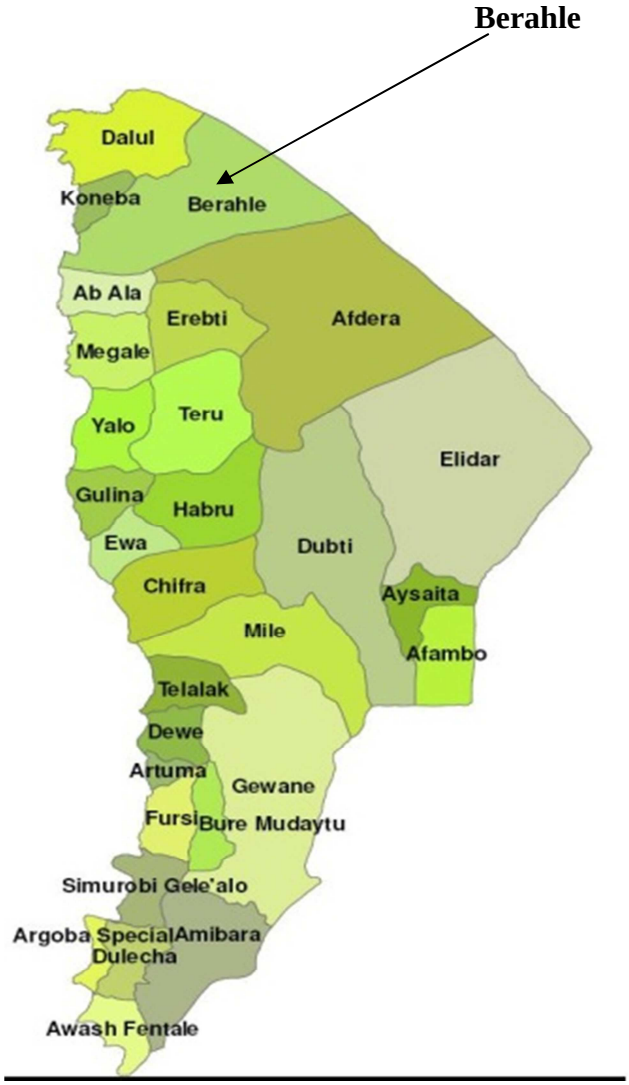
3.1 Description of the Study Area

Afar region is one of the regional states of Ethiopia located in the north eastern part of the country. The region is subdivided into five administrative zones and one special woreda and it has a total of 5 zones and 29 woredas.

The Ethiopian Central Statistical Authority (CSA) has estimated the 2008 population of the Afar Administrative Region at 1,449,000, of which 137,000 are urban residents. The breakdown by gender (803,000 males and 646,000 females) either stands out as a glaring example of data errors that produced highly lopsided numbers by sex, or suggests a troubling scenario of a harsh survival environment for female members of the population. The numbers suggest a sex ratio of 124 males per 100 females, often found among populations who have suffered a level of societal disruption such as excessive gender-specific migration, or excessive gender-specific mortality. Out of the total population of the region, 90 percent are pastoralists and the remaining 10 percent are agro-pastoralists. Those peoples in the region therefore depend mainly on livestock production for their livelihoods. The total fertility rate of the region is 4.9 which is below the national average. The native language in Afar region is Afarigna, which is of Cushitic origin.

Much of the land of the region is dry and rocky, which is unsuitable for crop cultivation. Out of the total area of the region (estimated at 97,250 km^2) cultivated and arable land constitutes 5.24 percent, forest 1.54 percent, bush and shrub 18.62 percent, grassland 1.56 percent, marshy land 2.74 percent, water bodies 0.63 percent, and degraded and rocky land 63.7 percent. The region's altitude ranges from a maximum of 1500m above sea level to a minimum of 166m below sea level. Temperature varies from 25ºC during the wet season to 48ºC during the dry season. Rainfall is erratic and scarce, and annual precipitation ranges from 200mm to 600mm. The region is frequently exposed to persistent droughts and is classified as one of the drought-prone regions in Ethiopia.

Figure 3.1: Location map of the study area (Berahle woreda)



Source: Aynalem (n.d)

The site in which the research has been conducted is **Berahle** woreda, one of the woredas in the region, located in the north eastern part of the region. It is part of Administrative Zone 2, and its territory includes part of the Afar Depression. This woreda is bordered on the south by Afdera and Abala, on the southwest by Tigray Region, on the west by Koneba, on the north by Dallol, and on the northeast by Eritrea. Towns in Berahle include Berhale and Tiyarabora.

The average elevation in this woreda is 233 meters above sea level. The major water body in this woreda is the saline Lake Karum (also known as Lake Assela). As of 2008, Berahle has 236 kilometers of all-weather gravel road and about 13 percent of the total population has access to drinking water.

Based on the 2007 Census conducted by the Central Statistical Agency of Ethiopia (CSA), this woreda has a total population of 78,881, of whom 45,501 are men and 33,380 are women. With an area of 2,509.17 square kilometers, Berahle has a population density of 31.44. A total of 11,402 households were counted in this woreda, which results in an average of 6.9 persons to a household, and 11,653 housing units. 98.93 percent of the population said they were Muslim, and 1.03 percent were Orthodox Christians. The woreda is found at a distance of 120 kilometers far from Mekelle (capital city of Tigray regional state) and around 993 kilometers from Addis Ababa (capital city of Ethiopia). Mining is the principal industry in this woreda and the best known resource extracted is salt**.**

3.2 Data Source and Sampling Procedure

3.2.1 Data Source and Data Type

In order to successfully achieve the stated objectives, the study employed both primary data (cross-sectional data) and secondary data. The primary data was collected through dispersing of structured questionnaire with face to face interview from selected sample households of the target area, direct observations and focus group discussions.

Enumerators, those who collect data from the sample households, were selected according to their level of education, data collection experience and their proficiency on the local language "Afarigna" and then were trained on the basic contents of the questionnaire and data collection techniques.

Before the main data collection, a pilot survey was conducted using some randomly selected households from the two groups of households (camel owners and camel non-owners) in order to check the efficiency of the questionnaire and to make some corrections if necessary. The main survey was conducted on November 2013.

3.2.2 Sampling Procedure and Sample Size

A multistage sampling technique (including both probability and purposive) was employed in order to reach at the selection of sample households used for the analysis. At the first stage, Berahle woreda was purposely selected, out of the total woredas of the zone due to the fact that the salt mining area is found within the boundary of this woreda and is under administration of the woreda. In the second stage, 1 kebelle (Berhale kebelle) out of the total 9 kebelles of the

woreda was selected; because it constitutes the highest number of salt transporters and camel renters even if there are few participants in the other 8 kebelles too.

Then after, a total of 250 sample households, including 115 treated (camel owners) and 135 controls (camel non-owners) were randomly selected and interviewed from all kushets of the kebelle. The kebelle has a total of 5 kushets.

Taking camel owning as a treatment, those households who own camels and use their camels for salt transportation either by renting out them for other salt transporters or transporting salt by themselves are referred to as treated and those households who do not have their own camels are referred to untreated or control group.

Households those who own camels but do not either transport salt by themselves or rent out them for other salt transporters and households those who do not own camels but transport salt by renting in camels from camel owners are excluded from this study. And the sample size does not constitute these groups. This is because:

- The formers, even if they are camel owners, they are getting nothing from salt trade while their camels are not involved in salt transportation. Hence, they cannot be considered as treated groups.
- The latters on the other hand, even if they don't own camels, while they are beneficiaries of camel salt transportation service by renting in camels from other camel owners, they cannot be considered as control groups too.

3.2.3 Questionnaire Design

In order to attain the stated objectives of the study, a structured questionnaire consisting of different sections, each section having different types of questions was developed. The developed questionnaire used for survey is presented in *Annex XII*.

The first section of the questionnaire asks respondents about the demographic characteristics of household members. The second section constitutes questions about the total asset ownership and value of the households. Basic assets included were land, livestock and fixed assets. But no one of the sample households was found with agricultural land ownership.

The questions in the third section of the questionnaire are related to incomes of the households in 2012/13 (2005 E.C.). The subsections under this income section are: the income that the households gained from employment for wage, own business activities, migrating to other places, sale of livestock and livestock by-products.

The fourth section constitutes questions related to camel rent and salt transportation experiences of the households. The fifth part is about the fodder and water that the households supply to their camels. And in the last section, the respondents were asked general questions about their camels and questions related to their life condition.

3.3 Methods of Data Analysis

For analysis purpose, this paper has utilized both descriptive and econometric data analysis methods.

3.3.1 Descriptive Method of Data Analysis

In the descriptive method of data analysis, the data collected from the sample households and FGDs was analyzed using statistical techniques like, tables, means, percentages, ratios, frequencies and charts.

In order to achieve the fourth objective of the study, i.e. in order to identify the main beneficiaries of the salt mine among the salt trade value chain participants; and calculate the profit percentage share of the salt transporters out of the total profit of the salt trade value chain participants, descriptive method of data analysis was employed.

In addition, the same method of data analysis was used to calculate returns from camel salt transportation service, the contribution of camel salt transportation service for employment and for the national economy.

3.3.2 Econometric Method of Data Analysis

For the proper estimation of the impact of camel transportation service on the livelihoods of the camel owner pastoral households, the paper has also employed econometric estimation models.

3.3.2.1 Econometric Framework and Estimation Strategy

When investigating the impact of camel transportation service on the livelihood of camel owner pastoral households (treated group) by comparing their livelihood with those who are non-owners (control or untreated group), the researcher faces a problem of estimation selection bias.

This is due to the fact that, to evaluate the impact of a treatment on performance indicators, it is necessary to draw a counterfactual scenario about the performance indicators of the treated group.

The counterfactual indicators would then be compared with the performance level of the treated when they become treated in order to evaluate the impact of the treatment on the performance indicators (Heckman *et al*., 1997).

For the camel owners (treated group) their counterfactual would be their livelihood condition in the absence of the gain from their camel ownership. While for the non-owners (control or untreated group), their counterfactual would be the level of their livelihoods if they have moved to camel owner status.

However, in reality a household cannot hold both actually treated and control group status and therefore it is only by constructing a counter factual group that the proper comparison can be made.

Thus, to eliminate selection bias, there is the need to compare the performance levels of treated and control groups which are statistically comparable (Rosenbaum and Rubin, 1983; Khandker *et al*., 2010). Rosenbaum and Rubin (1983) suggest the use of Propensity Score Matching (PSM) approach to deal with selection bias.

3.3.2.2 Propensity Score Matching (PSM)

Matching subjects on an n-dimensional vector of characteristics is typically unfeasible for large n; hence, this method proposes to summarize pre-treatment characteristics of each subject into a single-index variable (the propensity score) that makes the matching feasible.

In this study, it is possible to estimate the livelihood effect of camel salt transportation service by matching how livelihood indicators differ for households who own camel and use them for salt transportation relatively to observationally similar camel non-owners.

In analyzing using PSM approach, the following assumptions have to be held.

(A) Conditional Independence Assumption (CIA): states that given a set of observable covariates *X* which are not affected by treatment *T* (camel ownership in this case), potential outcomes Y (where Y is the set of livelihood indicators like income, fixed asset formation and livestock ownership) are independent of the treatment assignment *T*. If Y^T represents outcome indicators of the treated group (camel owners) and Y^C represents outcome indicators of the control group (camel non-owners), then, the conditional independence assumption implies that:

$$(Y^T, Y^C) \perp T \mid X \qquad \text{for all } X$$

Where $\perp$ represents independence.

This assumption is also called *unconfoundedness* (Rosenbaum and Rubin 1983), and it implies that uptake of the treatment is based entirely on observed characteristics. Selection is solely based on observable characteristics and that all variables that influence treatment assignment and potential outcomes are simultaneously observed.

Conditioning on all relevant covariates is limited in case of a high dimensional vector *X*. According to Rosenbaum and Rubin (1983), to overcome the problem of dimensionality for non-randomized observations, treatment and outcome are independent of the propensity to score *P(X)*, which is a conditional probability of an individual to participate in a treatment given his observed covariates *X* which is so called *balancing score*. It shows that, if potential outcomes are independent of treatment conditional on covariates *X*, they are also independent of treatment conditional on a balancing score.

The conditional independence assumption (CIA) based on the propensity score (PS) can be written as:

$$(Y^T, Y^C) \perp T \mid P(X) \qquad \text{for all } X$$

(B) Common Support or overlap condition: states the phenomenon of perfect predictability of *T* given *X*:

i.e., $0 < P(T = 1 \mid X) < 1$ where *T* is camel ownership

It ensures that persons with the same *X* values have a positive probability of being both camel owners and non-owners (Heckman *et al.*, 1999).

There are two steps that have to be followed in order to conduct an assessment on the impact of camel salt transportation service on the livelihood of camel owner pastoral households in the study area using PSM approach.

- Estimating the probability of households' camel ownership and
- Estimating the livelihood contribution of camel salt transportation service for the camel owner pastoral households

I. Model for the analysis of the determinant factors those affect households' camel ownership

Binary model is used to estimate households' probability of being treated (being camel owner) on observable characteristics. Since propensity score is a conditional probability estimator, any discrete choice model such as logit or probit can be used as they yield similar results (Caliendo and Kopeinig, 2008).

The two models are basically the same except the difference they have in their distribution:

Logit – Cumulative standard logistic distribution (*F*)

Probit – Cumulative standard normal distribution (Φ)

In this study, logit model is used as a binary model in order to estimate households' probability of camel ownership.

- Logit model is a non-linear regression model and is appropriate when the dependent variable is binary (dummy) which takes values of either 0 or 1. It estimates the probability of the dependent variable to be 1 i.e., $P(X_i) = 1$ (Gujarati, 2004).

The form of the logit model is:

$$P(X_i) = P(camel\_ownp = 1 / X_i) = F(\beta_0 + \beta_k X_i + \varepsilon)$$

Where: $P(X_i)$ = is the probability of households' camel ownership

X_i = is a set of all observable characteristics those affect the probability of households' camel ownership

β_0 = is the constant term

β_k = is a set of parameters of interest to be estimated

ε = is the disturbance term

The logit model is then specified as,

$$P(X_i) = P(camel\_ownp = 1 | X_i) = F(X_i\beta) = \frac{e^{X_i\beta}}{1+e^{X_i\beta}} = \frac{1}{1+e^{-X_i\beta}}.$$

Where, $X_i\beta = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots\ldots\ldots\ldots\ldots\ldots + \beta_k X_k$

P(X$_i$) is nonlinear not only in *X* but also in the *β*'s.

The probability of households' camel non-ownership is given by:

$$1 - P(X_i) \;\; = P(camel\_ownp = 0 | X_i) = 1 - \frac{e^{X_i\beta}}{1+e^{X_i\beta}} = \frac{1}{1+e^{X_i\beta}}.$$

Therefore, we can simply derive the *odds ratio* **(**the ratio of the households' probability of camel ownership to the probability of camel non-ownership). It can be written as:

$$\frac{P(X_i)}{1-P(X_i)} = \frac{\frac{1}{1+e^{-X_i\beta}}}{\frac{1}{1+e^{X_i\beta}}} = e^{X_i\beta}$$

$e^{X_i\beta}$ = is the odds ratio

If we take the natural logarithm of the above equation, we obtain:

$$L_i = \ln(\frac{P(X_i)}{1-P(X_i)}) = \ln e^{X_i\beta} = X_i\beta = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_i + \ldots\ldots\ldots\ldots\ldots \beta_k X_k$$

L$_i$, the log of the **odds ratio**, is not only linear in *X*, but also linear in the parameters (Rosenbaum and Robin (1983), Bryson *et al.* (2002)).

L$_i$ is called the **logit model.**

Then, we have the logistic estimation as:

$$\text{Prob}(camel\_ownp = 1) = L_i = \ln(\frac{P(X_i)}{1-P(X_i)}) = X_i\beta$$

Where

$$X_i\beta = \beta_0 + \beta_1 sexhh + \beta_2 agehh + \beta_3 educhh + \beta_4 acc\_credit + \beta_5 fam\exp\_co + \beta_6 adulthh + \beta_7 adul\_ratio + \varepsilon_i$$

Maximum Likelihood Method **(MLM)** of estimation is used to estimate these parameters of interest.

Finally, propensity scores of each individual household are estimated from the logistic regression. Propensity scores close to 1 indicate treatment characteristics associated with a high probability of camel ownership, which are calculated for each treated by applying their background values to the logistic model.

II. Model to analyze livelihood contribution of camel salt transportation service for the camel owner pastoral households

The propensity score matching produce valid matches which can be used to estimate impact of camel salt transportation service on livelihood at the second stage of the analysis after the propensity score $P(X_i)$ is known in the first stage. This is done by matching the two groups of respondents on the basis of the predicted propensity score (Backer and Ichino, 2002).

According to Roy-Rubin model (Roy (1951) and Rubin (1974)), the impact of a treatment on the outcome of a household involves speculation about how this household would have performed had it not received the treatment. In the case of a binary treatment, the treatment indicator T_i equals 1 if household *i* is treated (camel owner in this case) and zero otherwise. The potential outcomes (income, livestock ownership and fixed asset formation) are then defined as Y_i (T_i) for each household *i*, where i = 1,……,N and N denotes the total population. The treatment effect i.e. the effect of the gain from camel salt transportation service for a household *i* can be written as:

$$TE_i = Y_i(1) - Y_i(0)$$

Where, $Y_i(1)$ is the outcome of household *i* after being camel owner and

$Y_i(0)$ is the outcome of the household before having camels

But a problem arises because only one of the potential outcomes is observed for each household *i*. The unobserved outcome is called counterfactual outcome. Hence, estimating the individual household treatment effect TE_i is not possible; we have to shift to the population average treatment effect.

`Average treatment effect on the treated' *(ATT)* is a parameter of interest with a great attention in most literatures and is estimated as follows:

$$ATT = E(ATT|T_i = 1) = E[Y_i(1)|T_i = 1] - E[Y_i(0)|T_i = 1]$$

However, $E[Y_i(0)|T_i = 1]$, which is a mean counterfactual for those being treated is not observable. Hence, in order to estimate the *ATT*, it has to be replaced by proper substitute.

Using the mean outcome of untreated individuals $E[Y_i(0)|T_i = 0]$ as a counterfactual for the treated may result in biased estimates. This is because the outcomes of households from treatment and comparison groups would differ even in the absence of treatment leading to a `self-selection bias' (Caliendo and Kopeinig, 2005).

However, in social experiments where assignment to treatment is *random*,

$E[Y_i(0)|T_i = 1]$ - $E[Y_i(0)|T_i = 0]$ =0 and the treatment effect is identified.

Therefore, *ATT* is the mean difference in outcomes of the two groups of households over the common support appropriately weighted by the propensity score distribution of participants.

Four different matching algorithms which involve trade-offs in terms of bias and efficiency are used in the study to match treated (camel owner) and control (camel non-owner) households. These are:

1. **Nearest Neighbour Matching (NNM)**
   - Under this method, a control unit can be a best match for more than one treated units (using replacement). It consists of taking each treated unit and searching for the control unit with the closest propensity score. In NNM, all treated units find a match (Backer and Ichino, 2002).
   - Once each treated unit is matched with a control unit, the difference between the outcome of the treated units and the outcome of the matched control units is computed. The *ATT* is then obtained by averaging these differences.

2. **Radius Matching (RM)**
   - In this algorithm, a household from the control group is chosen as a matching partner for a treated household that lies within the specified radius in terms of

propensity score. I.e. each treated unit is matched only with the control units whose propensity score falls into a predefined neighborhood of the propensity score of the treated unit.

3. **Kernel Matching (KM)**
   - In KM, each treated is matched with a weighted average of all controls with weights that are inversely proportional to the distance between the propensity scores of treated and controls.
   - All respondents of the underlying sample of control group are included; and weight more distant observed characteristics among both groups of households down (Heckman *et al*., 1997). The Kernel based estimator of the ATT describes the mean difference in outcome while the matched outcome is given by Kernel-weighted average of the outcome of control group of respondents.
4. **Stratification Matching (SM)**
   - Consists of dividing the range of variation of the propensity score in intervals such that within each interval, treated and control units have on average the same propensity score. Then, within each interval in which both treated and control units are present, the difference between the average outcomes of the treated and the controls is computed.
   - The *ATT* of interest is finally obtained as an average of the *ATT* of each block with weights given by the distribution of treated units across blocks.

The above four matching algorithms reach different points on the frontier of the trade-off between quality and quantity of the matches, and none of them is a priori superior to the others. Their joint consideration, however, offers a way to assess the robustness of the estimates. It should also be noted that with all these methods, the quality of the matches may be improved by imposing the common support restriction (Lechner, 2001).

For further details of these matching algorithms and their STATA software commands, we refer to Becker and Ichino (2002).

In general, while estimating the average treatment effect of camel salt transportation service on the livelihood of camel owner pastoral households using the stated matching algorithms, the common support restriction is imposed and their joint estimation is considered.

III. Sensitivity Analysis

PSM cannot control for unobservable characteristics. It can only control the observed variables which are included in the propensity score used to match the two groups of households (Caliendo and Kopeinig, 2005 and 2008; Rosenbaum and Silber, 2001). Thus, a question arises whether the obtained superior livelihood level of camel owners is due to their camel ownership or their other unobserved characteristics. Hence, before interpreting the baseline estimate as evidence of a true causal effect of the treatment, testing the presence of unobserved variable becomes a greater importance which can be done by using sensitivity analysis (Rosenbaum, 2002). Sensitivity analysis is used to assess whether and to what extent the estimated average treatment effects are robust to possible deviations from the conditional independence assumption (CIA) (Nannicini, 2007).

It is assumed that treatment assignment does not hold the CIA assumption given the set of covariates *X* but holds given *X* and an unobserved binary variable *U*. As long as *U* is not observed, the outcome of the controls cannot be credibly used to estimate the counterfactual outcome of the treated. On the contrary, knowing *U* (together with the observable covariates *X*) would be enough to consistently estimate the ATT.

In order to make the simulation of the potential confounder feasible, *U* is assumed to be binary and conditionally independent with respect to *X*. The distribution of the binary confounding factor *U* is fully characterized by the choice of four parameters: $p_{ij} \equiv \Pr(U=1|T=i, Y=j) = Pr(U=1|T=i, Y=j, X)$ with $i, j \in \{0,1\}$ which give the probability that *U* = 1 in each of the four groups defined by the treatment status and the outcome value and then a value of *U* is attributed to each unit. In case of continuous outcomes, the simulation parameters p_{ij} are defined on the basis of *T* and a binary transformation of *Y* instead of the outcome itself. Thus, $p_{ij} \equiv \Pr(U=1|T=i, I(Y>y^*)=j)$ with $i, j \in \{0,1\}$, where *I* is the indicator function and *y** is a chosen typical value of the distribution of *Y*.

The simulated *U* is then treated as any other observed covariate and is included in the set of matching variables used to estimate the propensity score and to compute the *ATT*. Using a given set of values of the sensitivity parameters, the matching estimation is repeated 50 times in this case and a simulated estimate of the *ATT* is retrieved as an average of the *ATTs* over the distribution of *U*, which is robust to the failure of the CIA implied by that particular configuration.

Of the three alternative variances: within-imputation, between-imputation and total, total variance is used in this analysis which leads to conservative inferential conclusions, since it is always greater than the other two alternatives. While computing a standard error for the simulated *ATT*, the imputation of *U* is considered as a normal problem of missing data, which can be solved by repeatedly imputing the missing values of U. Then, the total variance associated to $A\hat{T}T$ can be expressed as:

$$se^2{}_T = \frac{1}{m}\sum_{k=1}^{m} se^2{}_k + (1+\frac{1}{m})(\frac{1}{m-1}\sum_{k=1}^{m}(A\hat{T}T_k - A\hat{T}T)^2)$$

Where *m* is the number of imputations of the missing U, and

$A\hat{T}T_k$ and $se^2{}_k$ are the point estimate and the estimated variance of the *ATT* estimator at the *k-th* imputed data set (with *k = 1, 2, . . . ,m*). The simulated *ATT*, $A\hat{T}T$, is obtained by the average of the $A\hat{T}T_k$ over the *m* replications.

A grid of different p_{ij} is built, in order to capture the characteristics of the potential confounders that would drive the *ATT* estimates to zero or far away from the baseline result. According to Ichino, Mealli and Nannicini (2007), by simply choosing the parameters p_{ij} it is possible to simulate a "dangerous" confounder (a confounder whose existence might give rise to a positive and significant *ATT* estimate even in the absence of a true causal effect) if following implications hold:

$$p_{01} > p_{00} \Rightarrow \Pr(Y_0 = 1|T = 0, U = 1, X) > \Pr(Y_0 = 1|T = 0, U = 0, X)$$

$$p_{1.} > p_{0.} \Rightarrow \Pr(T = 1|U = 1, X) > \Pr(T = 1|, U = 0, X)$$

Therefore, by simply assuming that $p_{01} > p_{00}$ and $p_{1.} > p_{0.}$ one can simulate a confounding factor that has a positive effect on the untreated outcome Y_0 and on the treatment assignment (conditioning on *X*) respectively. Besides, the differences $d = p_{01} - p_{00}$ and $s = p_{1.} - p_{0.}$ are a measure of the effect of *U* on the untreated outcome and on the selection into treatment respectively. However, by setting the sensitivity parameters p_{ij} , we can control the sign but not the magnitude of the conditional association of *U* with Y_0 and *T*. To avoid this limitation, we can measure how each chosen configuration of the p_{ij} translates in terms of the effect of *U* on Y_0 and *T* (conditioning on *X*). At every iteration, a logit model of $\Pr(Y = 1|T = 0, U, X)$ is

estimated and the average odds ratio of U is reported as the "outcome effect" of the simulated confounder:

$$\Gamma = \frac{\dfrac{\Pr(Y=1|T=0,U=1,X)}{\Pr(Y=0|T=0,U=1,X)}}{\dfrac{\Pr(Y=1|T=0,U=0,X)}{\Pr(Y=0|T=0,U=0,X)}}$$

Similarly, the logit model of $\Pr(T=1|U,X)$ is estimated at every iteration and the average odds ratio of U is reported as the "selection effect" of the simulated confounder:

$$\Lambda = \frac{\dfrac{\Pr(T=1|U=1,X)}{\Pr(T=0|U=1,X)}}{\dfrac{\Pr(T=1|U=0,X)}{\Pr(T=0|U=0,X)}}$$

By simulating U under the assumptions that $d > 0$ and $s > 0$, both the outcome and selection effects must be positive (i.e., $\Gamma > 1$ and $\Lambda > 1$). Γ and Λ as an additional output of the sensitivity analysis, provide us the magnitude of these two effects, which end up characterizing the simulated confounder U.

In general, in this study, sensitivity analysis is used to identify whether the inference taken about the effect of camel ownership on the livelihoods of the camel owner pastoral households is reliable. The analysis is undertaken based on Nannicini (2007).

3.3.2.3 Model to identify the determinant factors affecting camel owner pastoral households' camel rent decision (Ordered Probit Model)

The decision of all of the camel owner pastoral households regarding way of their participation in salt trade is not the same. Some of them may decide to always rent out their camels for other salt transporters and being beneficiary from the salt trade in the form of camel rent; some of them may decide to always transport and sale salt by themselves; and some of them may decide to be involved in both of them i.e. sometimes to transport salt by oneself and sometimes to rent out camels for other salt transporters.

These differences in the camel rent decision of the camel owner pastoral households, attracts some interest to understand the determinants of these alternative decisions. Hence, to deal with the major pushing determinant factors of camel rent decision of the camel owner pastoral

households, ordered multinomial choice model is used. Furthermore, among the alternative two multinomial choice models i.e. ordered logit and ordered probit, the ordered probit model is used to investigate these determinant factors.

Multinomial model is used for a data in which the choice variable takes more than or equal to three values. Sometimes the categories of such discrete variables can be naturally ordered. If values of the choice variable can be ordered, we call it ***ordered multinomial choice model***.

Ordinal outcomes represent categorical outcomes where there is clear natural ranking or order from low to high among the outcomes but the distance between the adjacent categories is unknown. While modeling these types of outcomes, numerical values are assigned to the outcomes, but the numerical values are ordinal and reflect only the ranking of the outcomes and are no longer arbitrary. When ordering the responses of the choice variable, larger values are assumed to correspond to "higher" outcomes (Schmidheiny, 2007).

In this study, the choice variable is camel rent decision of the 115 camel owner pastoral households with three outcome categories.

1. ***Never***
2. ***Sometimes***
3. ***Always***

The *"never"* outcome category represents response of those camel owner pastoral households who always transport salt by themselves and have never been rented out their camels for other salt transporters; the *"sometimes"* represents response of households those who have been sometimes renting out their camels because they sometimes transport salt by themselves; and the *"always"* outcome category is assigned for the response of households those who were always renting out their camels for other salt transporters and have never been transported salt by themselves due to different factors to be identified and presented in the econometric analysis part of the paper. The average number of months per year in which the camel owner pastoral households have been renting out their camels for other salt transporters is 0, 3.5 and 8 for the households with camel rent responses of "never", "sometimes" and "always" respectively.

An ordered probit model, used in this analysis, is a latent variable model that offers a data generating process for categorical dependent variables (camel rent decision in this case) (Schmidheiny, 2007).

Let y_i be an ordered response taking the values (1, 2, 3) for (never, sometimes, always):

The ordered probit model for y_i, conditional on explanatory variables x_i, can be derived from a latent variable model y_i*, i.e.

$$y_i^* = \beta_0 + x_{1i}\beta_1 + x_{2i}\beta_2 ..... + x_{ki}\beta_k + \varepsilon_i$$

Or $$y_i^* = x_i\beta + \varepsilon_i$$

Where y_i* = latent index of camel rent decision and is a function of observed and unobserved variables

- Once y_i* crosses a certain value, first "never" is reported, then "sometimes" and finally the "always" category outcome follows.

x_i = vector of variables that explains the variation in the observed dependent variable

β_i = vector of coefficients and ε_i = the error term with cumulative distribution function *F (.)* in which the model is determined by its assumed distribution

In *ordered probit model,* the error term is independently and normally distributed with mean 0 and variance σ^2

$$i.e..\ F(\varepsilon_i) = \int_{-\infty}^{\varepsilon_i} \frac{1}{\sqrt{2\pi}} \exp\left(-\frac{1}{2}\varepsilon_i^2\right)$$

If the latent variable y_i^* denotes a natural ordering among the possible outcomes, then the observed dependent variable can form:

$$y_i = \begin{cases} 1 = Never & \mathrm{y_i}^* \le \mu_1 \\ 2 = Sometimes & \text{if} \quad \mu_1 < \mathrm{y_i}^* \le \mu_2 \\ 3 = Always & \mathrm{y_i}^* > \mu_2 \end{cases}$$

Where $\mu_1 < \mu_2$ are the two unknown cut points or threshold parameters to be estimated along with β in the model. In theory, the threshold values are different for everyone and their average across households is estimated.

These threshold parameters determine how the values of y_i^* to get translated into the three possible values of y_i.

Then, we have the ordered probit regression estimation as:

$$y_i^* = x_i\beta + \varepsilon_i$$

Where

$$X_i\beta = \beta_0 + \beta_1 agehh + \beta_2 educhh + \beta_3 adumale + \beta_4 acc\_credit + \beta_5 incomehh + \beta_6 camels\_hh + \varepsilon_i$$

Finally, given the standard normal assumption for ε_i, the conditional distribution of y_i given x_i can be derived by computing each response probability.

The probability that a household chooses alternative 1 is:

$$\begin{aligned}\Pr(y_i = 1) &= \Pr(y_i^* \le \mu_1) = \Pr(\mathbf{x}_i\beta + \varepsilon_i \le \mu_1) \\ &= \Pr(\varepsilon_i \le \mu_1 - \mathbf{x}_i\beta) = \Phi(\mu_1 - \mathbf{x}_i\beta) = 1 - \Phi[x_i\beta - \mu_1]\end{aligned}$$

The probability that a household chooses alternative 2 is:

$$\begin{aligned}\Pr(y_i = 2) &= \Pr(\mu_1 < y_i^* \le \mu_2) = \Pr(\mu_1 < \mathbf{x}_i\beta + \varepsilon_i) \times \Pr(\mathbf{x}_i\beta + \varepsilon_i \le \mu_2) \\ &= \Pr(\varepsilon_i < \mathbf{x}_i\beta - \mu_1) \times \Pr(\varepsilon_i \le \mu_2 - \mathbf{x}_i\beta) \\ &= \Phi(\mathbf{x}_i\beta - \mu_1) - \Phi(\mathbf{x}_i\beta - \mu_2)\end{aligned}$$

The probability that a household chooses alternative 3 is:

$$\begin{aligned}\Pr(y_i = 3) &= \Pr(y_i^* > \mu_2) = \Pr(\mathbf{x}_i\beta + \varepsilon_i > \mu_2) \\ &= \Pr(\varepsilon_i > \mu_2 - \mathbf{x}_i\beta) = \Phi[x_i\beta - \mu_2]\end{aligned}$$

Maximum likelihood method (MLM) is used to estimate the model and to do this; a log-likelihood function is needed at the first stage.

Likelihood function

Adding up the three probability outcomes listed above gives us the likelihood function for the maximum likelihood estimation. i.e.,

$L = \sum_i [\Pr(y_i = m)]$ Where m goes from 1 to 3

And the log likelihood function is $\ln L = \sum_i \ln[\Pr(y_i = m)]$

$$L = \Pr(y_i = 1) \times \Pr(y_i = 2) \times \Pr(y_i = 3)$$

$$\ln L = \ln[\Pr(y_i = 1)] + \ln[\Pr(y_i = 2)] + \ln[\Pr(y_i = 3)]$$

Or $$\ln L = \sum_{y_i=1} \ln\left[1-\Phi[x_i\beta-\mu_1]\right] + \sum_{y_i=2} \ln\left[\Phi(\mathbf{x}_i\beta-\mu_1)-\Phi(\mathbf{x}_i\beta-\mu_2)\right] + \sum_{y_i=3} \ln\left[\Phi[x_i\beta-\mu_2]\right]$$

From this, only the sign of the estimated parameters β can be directly interpreted. A positive sign tells whether the choice probabilities shift to higher categories when the independent variable increases. Note, however that, the absolute magnitude of the parameters is meaningless as it is arbitrarily scaled by the assumption σ = 1. One can therefore e.g. not directly compare parameter estimates for the same variable in different subgroups. In order to be able to interpret the variables in terms of magnitude, one can obtain the category specific marginal effects from these (Schmidheiny, 2007).

Marginal Effects

Marginal effects show changes in the choice probabilities due to change in the independent variables assuming μ = 0 and σ^2 = 1 and are a function of:

- Point of expansion (x's)
- Frame of reference for outcome (y)

The marginal effects for each of the three choice probabilities are presented as follows.

$$\begin{aligned}\partial \Pr(y_i = 1)/\partial x_i &= \partial\left[1-\Phi[x_i\beta-\mu_1]\right]/\partial x_i \\ &= -\Phi(x_i\beta)\beta_i\end{aligned}$$

$$\begin{aligned}\partial \Pr(y_i = 2)/\partial x_i &= \partial\left[\Phi(\mathbf{x}_i\beta-\mu_1)-\Phi(\mathbf{x}_i\beta-\mu_2)\right]/\partial x_i \\ &= \Phi(\mathbf{x}_i\beta-\mu_1)\beta_i - \Phi(\mathbf{x}_i\beta-\mu_2)\beta_i\end{aligned}$$

$$\begin{aligned}\partial \Pr(y_i = 3)/\partial x_i &= \partial\left[\Phi[x_i\beta-\mu_2]\right]/\partial x_i \\ &= \Phi(x_i\beta-\mu_2)\beta_i\end{aligned}$$

3.4 Description of Variables Used in the Analysis

Review of literatures, idea of experts and knowledge of the researcher were used to identify the potential determinant factors of the assigned dependent variables used in this study. The assigned dependent variables to be analyzed are: households' camel ownership, livelihood indicators of the households and camel rent decision of the camel owner pastoral households. The independent variables which are expected to affect these dependent variables are

categorized into two groups; 1) Households' demographic characteristics and 2) Socio-institutional and economic factors.

The description of the variables is presented below.

1. **Treatment variable: -** the treatment variable used in this study is ***households' camel ownership (camel_ownp)*****;** whether a household own camels or not, with a binary value of 1 if the household is camel owner and 0 if not.
2. **Livelihood indicators: -** the following three variables are livelihood indicators of the households used for the impact assessment.
   - **i)** ***Income (incomehh):-*** is a continuous variable which measures the total annual income of a household. It is the summation of the incomes that the household members earn from employment for wage, own business activities, income collected by migrating to other places, sale of livestock and livestock by-products. Income from agricultural output is not included while no one of the sample households was found to be with land ownership. Of all the previously mentioned sources of income, income from own business activities is expected to contribute more for the difference in the income level between the camel owners and non-owners, because income from salt trade is included under this category. Income from farm output is not included as a source of income for the sample households; because no one of the households was found with agricultural landholding. Moreover, since income may produce inaccurate data, we also consider the following two alternative measures to evaluate the contribution of camel salt transportation service on the livelihood of the camel owner pastoral households.
   - **ii)** ***Fixed asset formation (ass_value):-*** The total fixed asset formation of a particular household is measured by summing up the monetary value of the fixed assets of the household such as house, radio, tape recorder, television, mobile phone, bed, refrigerator etc. It is a continuous variable and is used as an alternative livelihood indicator in this study.
   - **iii)** ***Livestock ownership (tlu):-*** is a continuous variable quantifying the number of livestock owned by a household measured interms of tropical livestock unit (TLU). Livestock are source of income and are considered as a wealth indicators for their owners. Livestock owners can convert their livestock into cash at any time that they want; by selling them or selling their by-products such as their meat, milk,

butter, skins and hides. This sales value is one source of income for the households and is expected to create them a capacity to buy fixed assets.

3. **Camel rent decision (cmlrent_dec):-** Almost all of the camel owner pastoral households in the study area are gainers from their camels' salt transportation service; but not in the same way. These households do have their own respective independent decision making power. As a result, some of them may decide to always rent out their camels for other salt transporters and receive camel rent; some of them may also decide to sometimes rent out their camels and sometimes transport salt by themselves; and some fraction of them may decide to never rent out their camels for others but to always transport salt by their own. This implies that, a particular household do have three alternatives about its camels' rent decision; to "never" or "sometimes" or "always" rent out them. Hence, the variable camel rent decision is an ordered discrete variable with values of 1, 2 and 3 in which 1 represents the camel owner pastoral households those who "never", 2 those who "sometimes" and 3 those who "always" rent out their camels for other salt transporters.
4. **Independent variables:-**

   i) Households' demographic characteristics

Sex of the household head (sexhh):- is one of the independent variables of the analysis. It is a dummy variable in which 1 is assigned for male household heads and 0 for female household heads. Male-headed households are expected to have a higher probability of owning camels than their counterparts due to their better capability of herding camels which is a difficult task. In addition, the salt mining area is somehow far from the study center, Berhale kebelle. If an individual residence of the kebelle wants to transport salt using camels, he is expected to walk for days on foot (walking long hours per day) to arrive there. Due to the effort exertion that these tasks demand, it is difficult for females to do these activities by themselves. Hence, they are expected to have a lower likelihood of owning camels than males. As a result of their higher likelihood of camel ownership and the expected economic contribution of camel salt transportation service, male-headed households are expected to be more likely capable of having higher income, much number of livestock, more asset value and better livelihoods than the female headed households.

Age of the household head (agehh):- is a continuous variable which is expected to affect all of the outcome variables. It is supposed that, an increase in age of the household head causes an increase in income of the household until the stage in which the increase in age is within the productive labor force. However, as the household head gets older and older, his managerial

ability and physical capability is expected to decrease which results in decrease in his income and livestock ownership.

Similarly, as far as their camel rent decision is concerned, elder household heads are expected to more likely rent out their camels for other salt transporters since they can't transport salt by themselves due to the difficulty of the task. In addition, the elder household heads are more likely expected to have less probability of camel ownership because they do distribute their camels among their married children.

Literacy of the household head (educhh):- is a dummy variable in which 1 is assigned to literate household heads and 0 is assigned for the illiterate ones. Literate household heads are expected to have better opportunity to be employed for wage in organizations in which skilled labor and professional is demanded. Due to this fact, their likelihood of participating in salt transportation and camel ownership in general is expected to be low. Moreover, household heads with relatively higher level of education are supposed to have better livelihood due to their ability in money and time management and their opportunity to have good job with better income than those who are uneducated. In general, being literate is expected to decrease the probability of camel ownership, increase the likelihood of renting out camels and have a positive impact on livelihoods.

Number of adult members in the household (adulthh):- is a continuous variable measured in number of household members of age between 15 and 64 years. It is the summation of both male and female adult members in the household. Households with large number of adult members are supposed to have higher likelihood of owning camels than those with few adult members, due to their better capability of purchasing camels and undertaking the heavy tasks of herding camels. Hence, the variable is expected to have a positive impact on the households' probability of camel ownership and on the livelihood indicator outcome variables.

Number of adult males in the household (adumale):- is a continuous variable which quantifies the number of male adult members in the household. Large number of male adult members is supposed to increase the likelihood of self-salt transportation decision and decrease the likelihood of renting out camels of the household.

Adult ratio for the household (adul_ratio):- is the ratio of male adult members to female adult members in the household. Even if having large adult members in a household is supposed to have a positive impact on camel ownership of that particular household, identifying either

having large number of male adult members per female adult member or vice versa increases the likelihood of owning camels is important. Therefore, it is hypothesized that, an increase in the ratio have a positive impact on the likelihood of camel ownership and the outcome variables of the household.

ii) Socio-institutional and economic factors

Access to credit (acc_credit):- is a dummy variable taking a value of 1 if the household head has ever had an access to credit from any type of credit provider and 0 if the household head has never been borrowed from any lender. Credit creates a capacity for a household to purchase a fixed asset or livestock such as camel at a time which may be impossible or take long time if it was thought to be purchased by timely saving from ones income. Hence, access to credit is expected to increase ones likelihood of owning camels.

In addition, to transport salt, a particular salt transporter is expected to pay tax for the salt that he is going to transport before going to the salt mining area. This implies, some amount of initial capital is needed to transport salt. Thus, households with an access to credit can have better capacity to transport salt by themselves than their counter parts and the variable is expected to have a negative effect on camel owner households' likelihood of always renting out their camels.

Camel ownership of parents of the household head (famexp_co):- is a dummy variable where 1 is assigned to those household heads with camel owner parents and 0 for those with camel-non-owner parents. It is expected that, the probability of camel ownership of those household heads with camel owner parents be higher than their counterparts. This is because; they have a higher likelihood of being experienced on how to herd camels and getting camels from their parents in the form of gift or inheritance.

Number of camels owned by the household (camels_hh):- in the study area, almost all of the camel owner pastoral households do participate in salt trade either directly by transporting salt or indirectly by renting out their camels. This indicates that, this salt trade is one of the sources of their income in which its amount depends on the number of camels that they own. The number of camels is a continuous variable and is hypothesized to have a negative effect on the likelihood of renting out camels. As the number of camels that a household owns increases, its probability of renting out them for other salt transporters is expected to decrease as far as their number is large enough to make the household head profitable by salt self- transporting.

In general, independent variables which are expected to affect the likelihood of households' camel ownership are: sex, age and literacy of the household head, access to credit, camel ownership of parents of the household head, number of adult members in the household and adult ratio for the household. On the other hand, determinant variables which are expected to influence households' camel rent decision are: age and literacy of the household head, number of adult male members in the household, access to credit, income of the household and number of camels owned by the household.

Table 3.1 Description of dependent and independent variables used for analysis in the study

Variable Name	Description
Treatment variable	
camel_ownp	Households' camel ownership (1=Ownership, 0=Non-ownership)
Livelihood indicators	
incomehh	Annual income of a household (Continuous)
tlu	Tropical livestock unit of a household (Continuous)
ass_value	Value of fixed assets for a household (Continuous)
Decision variable	
cmlrent_dec	Camel owner pastoral households' camel rent decision (1=Never, 2=Sometimes, 3=Always)
Independent variables	
sexhh	Sex of the household head (1=Male, 0=Female)
agehh	Age of the household head (Continuous)
educhh	Literacy of the household head (1=Literate, 0=Illiterate)
acc_credit	Access to credit (1=Yes, 0=No)
famexp_co	Camel ownership of household head's parents (1=Yes, 0=No)
camels_hh	Number of camels owned by the household (Continuous)
adulthh	Number of adult members in the household (Continuous)
adumale	Number of adult male members in the household (Continuous)
adul_ratio	Adult ratio for the household (Continuous)

CHAPTER FOUR

4. RESULTS AND DISCUSSIONS

The raw data which is collected from 250 sample households through dispersing of structured questionnaire and the data collected from FGDs is analyzed using descriptive and econometric methods of data analysis.

In this chapter, results of the descriptive and econometrics estimations will be presented. The descriptive analysis presents, the analysis of socio-economic and demographic characteristics of the sample households; salt transportation and camel rent experiences of the camel owner pastoral households; the profit proportion of the salt transporters out of the total profit of the salt trade value chain participants; the returns from camel salt transportation service, the contribution of camel salt transportation service for employment and for the national economy using statistical techniques like: tables, means, percentages, ratios, frequencies and charts.

In the econometric analysis, factors those determine the households' camel ownership are identified by logistic regression of the treatment over some independent variables. Moreover, the impact of camel ownership as well as salt trade value chain participation on the livelihoods of the camel owner pastoral households is analyzed by comparing the livelihoods of the camel owners with the non-owners using propensity score matching. Secondly, ordered probit regression model is employed to identify the determinant factors behind households' camel rent decision.

4.1 Descriptive Analysis

The detailed description and summary statistics of all the variables used for analysis is presented in *Annex I and IV*.

4.1.1 Households' Socio-Economic and Demographic Characteristics

Demographic Characteristics

Out of the total 250 sample households from which the survey is conducted, the 115 (46 percent) are camel owners and the remaining 135 (54 percent) camel non-owners. Regarding sex of the household heads, 230 (92 percent) of the households are male headed and the remaining 20 (8 percent) are female headed. The female headed households are most likely camel non-owners in which only 6 (30 percent) of them are camel owners. All of the respondent household heads were Muslims in which 228 (91.2 percent) of them are pastoralists

and the remaining 22 (8.8 percent) are non-pastoralists. The pastoralists include all of the camel owner pastoral households and most of the camel non-owner households which herd other types of livestock.

The mean household size for the total sample households is 4.8 which range from a minimum of 1 to a maximum of 10 members in a household. 239 (95.6 percent) of the respondent household heads are married and the remaining 11 (4.4 percent) are unmarried in which 3 single, 2 separated and 6 widowed household heads are merged together. The mean age of the household heads is 37.3 with a minimum and maximum of 20 and 68 years old respectively.

As far as literacy of the household heads is concerned, it includes two categories; literate and illiterate. The literate household heads are those who have ever been attended formal school whatever their level of schooling is (their highest educational achievement could be primary, junior, secondary or post-secondary). On the other side, the illiterates' category includes those household heads that have never been attended formal school even if they could have the ability of writing and reading. Accordingly, 190 (76 percent) and 60 (24 percent) household heads are found to be illiterate and literate respectively. Out of the total 115 camel owner household heads, only 20 (17.4 percent) of them are observed that they are literate.

The presence of a number of adult members in household, particularly male adult members, which is supposed to contribute for livelihood positively, was considered for each household. The mean number of male adult members is 1.59 for each household which ranges from having no adult male member at all up to having 6 male adult members in a household. However, the camel owner pastoral households are found having at least 1 male adult member. This implies that, camel owner households are more likely with much number of adult male members than the camel non-owners. The adult ratio which is the ratio of adult male members to adult female members of a household for the entire sample is around 1.30, with minimum and maximum values of 0 and 6 respectively.

The mean number of dependent members per independent member i.e. dependency ratio is 0.36 for the total sample households ranging from households with no dependent members to households with 0.75 dependents per independent.

Socio-Institutional Characteristics

The sample households were asked whether they have an access to credit or not; and for those who said yes, for what purpose most of the time they borrow. The data of their responses

shows that, only 17.2 percent or 43 household heads have credit experience, but the remaining 207 (82.8 percent) household heads said, “no! I have never been borrowed money from any one before”. The major potential reasons for the borrowing of the household heads with an access to credit are: to buy livestock, to buy house properties, to pay salt tax, to finance trade, to buy food and to cover health expenses of household members with respective percentage shares of 20.9 percent, 16.3 percent, 16.3 percent, 16.3 percent, 13.9 percent and 4.7 percent. The remaining 11.6 percent households do borrow money for different purposes including purchasing camel feed, house and building materials.

Regarding extension service participation of households, 159 (63.6 percent) of the total sample households do participate in health extension service. Of which, the 66 (41.5 percent) households are camel owners but the remaining 93 (58.5 percent) are camel non-owners.

There are different local institutions in the kebelle in which this survey is conducted. The number of participant households in these local institutions out of the total 250 sample households is referred to be 105 (42 percent). Of which, the 37 (35.2 percent) households are from the camel owner group of households. Based on the number of member households, the major local institutions in which those 105 households do mainly participate are: “Assaele salt trade cooperative”, “equb”, “both equb and Assaele salt trade association” and “Idir” with 55 (52.4 percent), 34 (32.4 percent), 6 (5.7 percent) and 4 (3.8 percent) respective number of member households. The remaining 6 (5.7 percent) households have stated that they participate in other small neighborhood level associations.

Households residing in different kushets of Berhale kebelle do not have an equal access to basic social services such as electricity and drinking water. Basically, drinking water, which is supposed to be basic for the healthiness of a society, is not as such available for all households. Of the total 250 sample households, only 185 (74 percent) households do have an access to clean water and only 181 (72.4 percent) households do have an access to electricity. However, it has to be noted that, this inaccessibility of the households to drinking water and electricity is not only due to unavailability of the services, but also due to the influence of the residence type of the households: whether it is temporary or permanent residence. Those households with permanent settlement are more likely with an access to clean water and electricity than the nomadic households.

The random sampling method used in this survey to select the respondent households has made the proportion of the households to be 4.1 settled households per 1 movable nomadic

household. I.e. the 201 (80.4 percent) households found to be permanently resident households and the remaining 49 (19.6 percent) nomadic pastoral households.

Economic Characteristics

The mean annual income of the 250 sample households is 29883.62 Birr with minimum and maximum amounts of 0.00 Birr and 395700.00 Birr respectively. The 0.00 Birr annual income concerns the households those who live by receiving remittance from their non-resident household members and aid from the government. They don't participate in income earning activities and some proportion of their consumption constitutes their livestock by-products.

The result from the raw data, concerning the number of participant households in each of the income earning activities within the year 2012/13 shows us that, out of the total sample households, members of the 118 (47.2 percent), 131 (52.4 percent), 7 (2.8 percent) and 76 (30.5 percent) were employed for wage, engaged in own business activities (such as handicraft, trade in livestock, selling salt, transporting goods by pack animal, and selling wood and charcoal), migrated to different places seeking job out of the kebelle and selling livestock by-products (mainly goat milk, butter and meat) respectively. Selling livestock by-products is common for the pastoral households in Berahle woreda and is one of the sources of their income and consumption. However, camel milk is not marketable there, since selling and purchasing of camel milk is forbidden in the area.

Out of the 118 households with employed for wage household members, only 40 households are from the camel owner group of households. This indicates that, the members of camel non-owner households do more likely participate in employment for wage than members of camel owner households.

Households' livestock ownership, measured in TLU conversion factor, is with a wide gap between the treated and untreated groups. The mean TLU for the total sample households is 4.97 with a minimum of 0 and maximum of 29.6 values per household. Differently, the mean TLU value for the camel owner pastoral households is 8.6, which is approximately twice of the mean TLU value for the total sample households. The minimum TLU value for the camel owner pastoral households is 1.51. The conversion factors used to estimate tropical livestock unit (TLU) are depicted in *Annex III.*

Regarding fixed asset formation of the households, the wealthy household has an asset value of 791,400 birr, and on the other extreme, there are households with 0 asset values indicating that

they are not owners of any kind of fixed asset. Merging these two extreme points together, the mean asset value of the total sample households is averaged to 36026.00 Birr per household.

As far as the number of camels owned by the camel owner pastoral households is concerned, the least number of camels owned by those households is 1 and the households with the largest number of camels do own upto 20 camels. The average number of camels for the households is 5.7.

The number of camel holdings of a particular camel owner household may remain constant, decrease or increase over time due to different factors. Of the 115 camel owner pastoral households of the survey, 53 (46.1 percent), 41 (35.6 percent) and 21 (18.3 percent) households has reported that, the number of their camels is decreasing, constant and increasing over time respectively. The main reasons mentioned by the households for the increment of their camels are reproduction due to their female camel ownership, purchase due to the increase in their income and improvement in their livelihood, inheritance and gift with a respective percentage shares of 52.4 percent, 33.3 percent, 9.5 percent and 4.8 percent. On the other side, the main factors for the decrement of the number of camels over time are observed to be recurrent drought (shortage of food and water), disease that causes death, rustling and sales with a percentage shares of 45.3 percent, 35.9 percent, 5.7 percent and 3.8 percent respectively.

The average number of years that the camel owner households have spent in camel production is 17.9 with a minimum and maximum of 1 and 50 years respectively.

Camel ownership of parents of the household head which is expected to be one of the major determinant factors affecting household's camel ownership was surveyed for each of the sample households. According to the responses of the household heads, only parents of the 80 (32 percent) household heads were camel owners. But the majority 170 (68 percent) household heads are from the camel non-owner families. Of the 80 household heads with camel owner parents, the 67 (83.75 percent) are currently camel owners too. This indicates that, household heads with camel owner parents do more likely continue to be camel owners than those with camel non-owner parents.

The short summary of the sample households' major socio-economic and demographic characteristics is presented as follows.

Table 4.1 Description of Households' Socio-Economic and Demographic Characteristics (Dummy and Categorical Variables)

Variable	Categories	Frequency	(% of the total sample)
sexhh	male	230	92
	female	20	8
educhh	literate	60	24
	illiterate	190	76
religion	Muslim	250	100
maritalhh	married	239	95.6
	unmarried	11	4.4
acc_credit	yes	43	17.2
	no	207	82.8
resid_type	permanent	201	80.4
	temporary	49	19.6
camel_ownp	yes	115	46
	no	135	54
pastor_hh	pastoral	228	91.2
	non-pastoral	22	8.8
famexp_co	yes	80	32
	no	170	68
cmls_overtime (for camel owners)	decreasing	53	46.1
	constant	41	35.6
	increasing	21	18.3
empt_wage	yes	118	47.2
	no	132	52.8

Source: Own Survey Data, 2013

Table 4.2 Summary of Basic Households' Socio-Economic and Demographic Characteristics

Variable	Combined		Camel Owners		Camel Non-owners		Difference		t-test	Pearson chi2(1)
	Mean	Standard Error	Mean	Standard Error	Mean	Standard Error	Mean	Standard Error		
sexhh	.92	.0172	.9478	.0208	.8963	.0263	-.0515	.0344		2.2404
agehh	37.296	.5399	37.496	.7788	37.1259	.7503	-.3697	1.085	-0.3407	
hhsize	4.752	.0967	5.026	.1515	4.5185	.1212	-.5076	.1918	-2.6462***	
maritalhh	.956	.013	.9652	.0172	.9482	.0192	-.0171	.0261		0.4301
educhh	.24	.0271	.1739	.0355	.2963	.0395	.1224	.0539		5.0993**
adulthh	2.936	.0866	3.0348	.1435	2.8519	.1038	-.1829	.1737	-1.0529	
adumale	1.592	.06004	1.6348	.0919	1.5556	.0792	-.0792	.1206	-0.6569	
adul_ratio	1.2976	.0507	1.2353	.0645	1.3501	.0759	.1149	.1017	1.1297	
depratio	.3649	.014	.3914	.0194	.3424	.0197	-.04898	.0279	-1.7573*	
empt_wage	.472	.0316	.3478	.0446	.5778	.0427	.22995	.0619		13.1762***
acc_credit	.172	.0239	.2	.0375	.1482	.0307	-.0519	.04797		1.1724
famexp_co	.32	.0296	.5826	.0462	.0963	.0255	-.4863	.0508		67.4937***
residence	1.2143	.0367	1.2174	.0386	1.1818	.12197	-.0356	.1305		0.0755
pastor_hh	.912	.018	1	0	.837	.0319	-.16296	.0346		20.5491***
camels_hh	2.628	.235	5.713	.3277	0	0	-5.713	.3023	-18.8978***	
yrs_cmlprod	8.228	.7335	17.887	1.0194	0	0	-17.887	.9405	-19.0179***	
incomehh	29883.62	2357.54	35984.92	3956.013	24686.21	2710.32	-11298.71	4685.15	-2.4116**	
tlu	4.9745	.319	8.642	.4832	1.8504	.1502	-6.792	.4747	-14.3088***	
ass_value	36026.2	3652.61	32410.17	2551.519	39106.52	6406.09	6696.35	7331.15	0.9134	
Difference = mean (camel non-owners) - mean (camel owners)										

Source, Own Survey Data, 2013

4.1.2 Households' Salt Transportation and Camel Rent Experiences

More than 99 percent of the camel owner pastoral households of Berahle woreda do engage their camels for salt transportation. This indicates that, almost all of the camels with carrying capacity found in the woreda are used to transport salt from the mining area to the market. The camels may undertake this task either under the leadership of their owners or the grooms who rented in them from their owners. Majorities, but not all of the camel owner pastoral households, do directly participate in salt transportation. Some of them do rent out their camels for other salt transporters and gain from the salt trade in the form of camel rent.

Accordingly, we can classify the 115 camel owner pastoral households under three categories; pure salt transporters (those who always transport salt by themselves and "Never" rent out their camels for other salt transporters), pure renters (those who "Always" rent out their camels for other salt transporters and never transport salt by themselves) and those households who undertake both activities ("Sometimes" rent out their camels and sometimes transport salt by themselves). The majorities or 67 (58.3 percent) households are categorized under the pure salt transporters and contrarily, the 29 (25.2 percent) households are under the category of pure camel renters. Only 19 (16.5 percent) of the households do have an experience of involving in both activities.

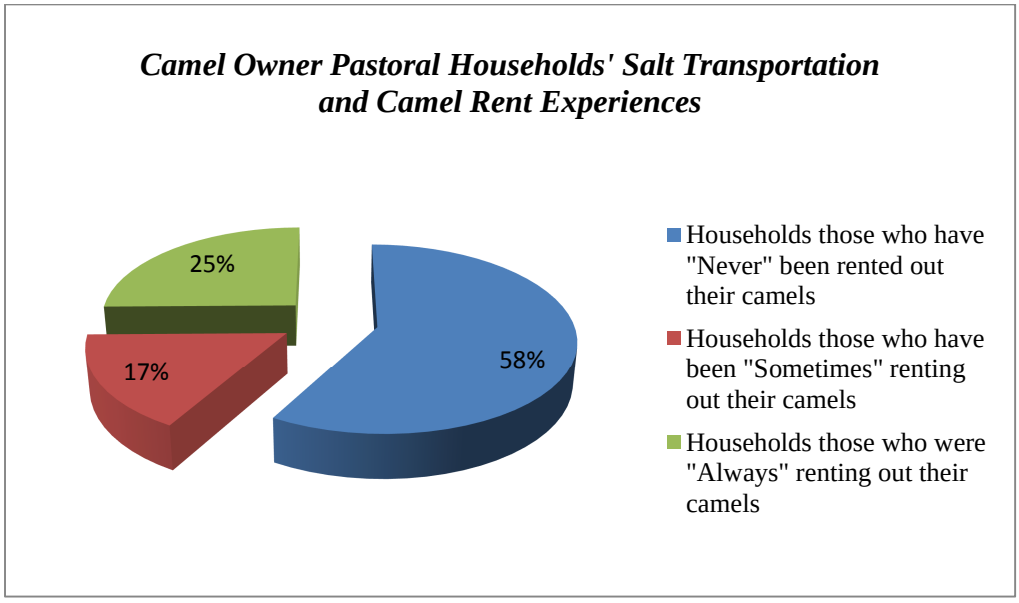
The short summary of the number and proportion of households under each category is presented in the table and figure below.

Table 4.3 Salt transportation and camel rent experiences of the camel owner pastoral households

Salt transportation experience	Camel rent experience		
	No	Yes	Total
No	135	29	164
Yes	67	19	86
Total	202	48	250

Source: Own Survey, 2013

Figure 4.1 The proportion of the camel owner pastoral households under the three categories of camel rent decision



Source: Own Survey, 2013

For the 86 households with salt transportation experience, the mean number of years that they have spent in salt transportation is 12 years which ranges from 1 to 42. Similarly, for the 48 households who have an experience of renting out camels, the mean number of years that they have spent in camel rent is 9 years with a minimum and maximum of 1 and 35 years respectively. This difference shows the camel owner's longer experience of transporting salt rather than renting out camels.

A particular household can have its own reasons those motivate it to rent out its camels for other salt transporters. The main motive that was observed from the response of the sample households with more likely camel renting experience is that, "the satisfaction that I get from my leisure time by renting out my camels is better than the income I can get by transporting salt myself". On the contrary, majority of the households with better experience of transporting salt rather than renting out camels have stated the main factors that hinder them not to rent out their camels for other salt transporters as "I want to use my camels by myself because I don't believe that anybody can take care of them like that of me" and "the income that I get by transporting salt myself is better than the income that I could get from camel rent".

4.1.3 Income of Camel Renters and Risk Sharing Between the Two Parties

When a camel owner rented out its camels for other salt transporter, the one round agreement between the camel owner and the transporter usually includes three successive salt transporting trips; the transporter to continuously transport salt three times. The income from the firstly transported total amount of salt by the rented camels is taken by the transporter, the income from the secondly transported salt by the camel owner but the income from the thirdly transported amount of salt is equally shared between the two parties. This reveals that, by renting out camels, camel owners can get half of the total income that could be gained from the salt trade as a result of the value of their camels' transportation service. If the two parties are agreed to continue further, they follow the same process again.

While transporting salt, there are different costs that have to be incurred related to the salt and the camels themselves; such as salt tax, payments to the salt miners, shapers, unloaders and camels' fodder expenses. All related costs are covered by the two parties equally. However, if some unexpected risks are occurred while in salt transportation (such as camel death), the loss goes to the camel owner and the transporter pays nothing. The only thing that is expected from the salt transporter is to provide evidence that the camel is died not sold. The evidence could be eyewitness or one part of the camel's body.

Camel renters are means and enablers of income generation for the grooms those who rented in camels from them. Thus, they are positioned as a ***credit granting institution (lender)***.

4.1.4 The Profit Proportion of the Salt Transporters Out of the Total Profit of the Salt Trade Value Chain Participants

"Sabanna-Demalie" is one of the 9 kebelles of Berahle woreda in which the salt mine is found. The name of the salt mining area is "Assaele". Assaele is found at a distance of 75 kilometers from the market center of the woreda, Berhale kebelle.

The name of the extracted salt from the area, particularly the shaped salt block which is supplied to market is "Asbo". It is a name given to it by the local community. But, it is also known as "Ganfur" by the peoples of Tigray region and "Amole chew" by the peoples of Amhara region.

The size of the salt blocks transported from the area is not the same. They are of three different sizes; small, medium and large. The name of the smallest, medium and biggest salt

blocks is “Gereweyna”, “Ankerabi” and “Geleo” respectively. However, only Gereweyna and Geleo are traded; because there is no market demand for the medium salt block, Ankerabi. Therefore, if the salt transporters allow their camels to carry this type of salt block, it is consciously for the purpose of their family consumption.

The salt passes through the following different stages and reaches at the hands of different salt trade value chain participant individuals to arrive at its final consumers.

1st The salt is extracted from the salt mine in the form of layers
2nd The extracted salt layers are shaped in to blocks, heaped on camels and then are packed
3rd The camels transport the salt from the salt mining area to the market place
4th Once they arrive at the market, the salt is unloaded from their back, counted and stored
5th Then, it is sold to wholesalers who came from other places particularly Mekelle
6th The wholesalers sale it to retailers
7th Finally, the retailers deliver it to its destination, consumers.

The value chain begins at salt miners and ends at salt retailers those who retail the salt to final consumers. Each of the above tasks is undertaken by different salt trade value chain participant groups of individuals: Salt miners, Salt shapers, Salt transporters, Salt unloaders, Salt store owners, Wholesalers and Retailers respectively.

Salt Miners: - The local name of the salt mining activity is “Fockollo”. Salt miners are individuals those who extract the salt from the salt mine in the form of layers. They usually receive payment after they extract an amount of salt layers which are much enough to be shaped into one camel carriage number of salt blocks.

Salt Shapers: - Salt shapers shape the salt layers extracted by salt miners into blocks, then heap and pack the shaped salt blocks atop of camels. The activity is locally named as “Hadelli”.

Salt Transporters: - Are individuals those who transport the salt blocks from the mining area in which it is extracted to the market place where it is sold. To arrive at the mining, they walk for days with their camels, walking for long hours per day. The average total number of days it took them to transport the salt including the time that they spent in double trip

transportation, salt loading and salt selling is 5 days. The payments made to the salt miners and salt shapers are covered by them.

Salt Unloaders: - Are salt trade value chain participants next to salt transporters. When the salt transporters arrive at the market with their salt loaded camels, the responsibility of these individual daily workers is to unload the salt from the camels, count it and layer it in the store.

Salt Store Owners: - Are shareholders of the salt store which is found in Berhale kebelle of Berahle woreda. The store serve as a market for the salt transporters where they sale the salt that they transported and it also serve as a salt store in which the salt is stored until it is sold to wholesalers. The store owners purchase salt from salt transporters and sale it to wholesalers.

All salt transporters are advised to sell their salt in this woreda market, even if it is not mandatory. Some time ago, very few salt transporters were trying to sale their salt in Koneba woreda market (which is a neighbour woreda) for individual buyers in which one biggest salt block is sold at an average price of 20.00 Birr with 2.00 Birr difference from the Berahle woreda market. But since this 2.00 Birr price increment is not that much profitable due to the far distance of the market, even the salt transporters themselves prefer to sale their salt in the Berahle woreda market for the store owners.

The name of the Cooperative of the store owners is “Assaele Salt Trade Cooperative” or is locally called “Assaele Chew Gebyit Sira Mahber”. It was established in September, 2010/11 and is owned by the residents of the woreda. The cooperative has around 4234 member shareholders and 34 employed workers. To be shareholder of the store, one can buy a minimum of 1,000.00 and maximum of 10,000.00 Birr shares but being resident of the woreda is mandatory.

Salt Wholesalers:- Are groups of individuals who come from different places (usually from Tigray) with their cars to purchase salt in bulk from the store owners and sell it to retailers found in the place where they come from. In this analysis, for simplicity, we calculate the profit of the wholesalers who come from Mekelle.

Salt Retailers:- Are the final salt trade value chain participants who purchase salt from wholesalers and retail it to consumers.

But who is the main beneficiary from the salt mine among these salt trade value chain participant groups of individuals? And how much is the profit share of the salt transporters out of the total profit of the salt trade value chain participants? In order to answer these questions, it is mandatory to undertake a cost-benefit analysis for each participant.

Due to the absence of market demand for the medium salt block, our concern tends to be only about the two types of salt blocks, smallest and biggest. The smallest is weighted about 4 Kgs and the weight of one biggest salt block is 7 Kgs.

Camels, in which the salt transporters use to transport salt, are different in size and age. Based on their size and age, they are usually categorized under three groups: adult, medium and young camels. As far as the amount of their carriage is concerned, a single adult camel can carry on average 22 biggest and 40 smallest salt blocks. If converted to Kgs, the carriage of the camel approximates to 154 and 160 Kgs for the two types of salt blocks respectively. The medium camel can carry around 16 biggest and 30 smallest salt blocks with respective total weights of around 112 and 120 Kgs. This means that, the medium camel can carry an amount of salt which weighs more than 70 percent of carriage of an adult camel. Camels, which are considered as a young, are allowed and capable of carrying small amount of salt relative to their counterparts. On average, they can carry and transport 12 biggest and 24 smallest salt blocks from the salt mine to the market, which approximates to respective total weight of 84 and 96 Kgs for the two types of salt blocks, showing their capability of carrying more than half of an adult camel's carriage.

Whether a camel is loaded biggest or smallest salt blocks, it is expected to exert the same level of physical effort. Because, the difference of the carriages is in the number and size of the salt blocks while the carriages' converted weight (in Kg) is similar. Therefore, due to this similarity, the analysis can be done using one of the salt block types. Here under, the analysis is undertaken per a single "***adult***" camel's carriage amount of ***"biggest"*** salt blocks.[2]

There is a high variation in the price of the salt across individuals and over time. All the calculations in this analysis are undertaken by using averages. Initially, the average price of the salt block is 1.00 birr at the hands of salt miners and finally is sold at an average price of 35.00 Birr by the retailers to consumers.

[2] All the cost, revenue and profit calculations undertaken for each of the salt trade value chain participants are per an amount of salt blocks which can be carried by a single adult camel. Moreover, of the three salt block types, the biggest salt blocks are used for the analysis.

While analyzing revenue, cost and profit of each of the salt trade value chain participants, the physical effort and time cost that they incur are excluded since they cannot be simply measured and converted into monetary value. Hence, only monetary costs are considered here. In addition, their food and water consumption expenditures are not taken into account.

Profit proportion of the salt trade value chain participants

A particular salt trade value chain participant's profit proportion is calculated as, the ratio of the profit of that particular value chain participant to the total profit of the salt trade value chain participants. And the total profit of the salt trade value chain participants is the summation of the profit gained by each participant.

The short summary of the detailed calculation of the Revenue, Cost, Profit and Profit percentage share of the salt trade value chain participants is presented in *Table 4.4* below.

Table 4.4 Revenue, Cost, Profit and Profit percentage share of salt trade value chain participants

Salt trade value chain participants	***Revenue per camel (In Birr)*** (a)	***Cost per camel (In Birr)*** (b)	***Profit per camel (In Birr)*** $(a-b)$	***Profit Percentage Share Per Camel (%)*** $\left(\frac{a-b}{617.9}*100\right)$
Salt Miners	23.00	0.00	23.00	3.7
Salt Shapers	88.00	0.00	88.00	14.2
Salt Transporters	396.00	137.40	258.60	41.9
Salt Unloaders	4.40	0.00	4.40	0.7
Salt Store Owners	440.00	410.70	29.30	4.8
Salt Wholesalers	616.00	555.45	60.55	9.8
Salt Retailers	770.00	616	154.00	24.9

Source: Own Computation, 2013

From the analysis, it can be understood that, the main beneficiaries of the salt mine among the seven salt trade value chain participants are salt transporters with a profit percentage share of 41.9%. In addition, a big difference is observed among the profit proportion of the value chain participants which indicates the existence of somehow unfair benefit distribution among them from the mineral.

4.1.5 Returns from Camel Salt Transportation Service

- Let's assume that there is a particular household who own 20,000.00 Birr. The household has two choices. Either to
  - Save the money in a bank and earn interest from the money

    Or
  - Purchase camel and use it for salt transportation

The average price of an adult camel is 20,000.00 Birr in Afar region.

To decide, the household has to compare the incomes that it can earn from the two alternatives.

1. *Income from Deposing Money*

If the household save the money in a bank, the total amount of interest that could be gained from one year deposition of the money can be calculated using the double (compound) interest formula. i.e.,

$$A = P\,(1 + \frac{r}{n})^{nt}$$

Where:

- A = Total amount of money accumulated after n years (including interest)
- P = principal amount (the initial amount the household deposit)
- r = annual rate of interest (as a decimal)
- n = number of times the interest is compounded per year
- t = number of years the amount is deposited

Given principal of 20,000.00 Birr with an annual interest rate of 5% which is compounded monthly,

Thus, $$A = 20000\,(1 + \frac{0.05}{12})^{(12)(1)}$$

$$A = 21023.24\,Birr$$

So, the total balance that the household receive from the bank after a year is approximately 21023.24 Birr with value addition of 1023.24 Birr.

2. *Income from Camel Salt Transportation Service*

If the household decide to purchase camel and use it for salt transportation, the camel can serve the household by transporting salt on average 3 times a month for successive 8 salt transporting months. In a single journey an adult camel provide a net profit of around 258.60 Birr for the transporter via its transportation service (without taking the fodder cost for the camel into consideration). Thus, the monetary value of the camel's transportation service, if it is properly herd and used for salt transportation is $258.60 Birr \times 3 \times 8 = 6206.40 Birr$ per year. As regards the camel fodder cost of the household, one camel do consume an average of $\frac{1}{2}$ daka[3] fodder per day. This implies, a single camel feed $\frac{1}{2} \times 30 \times 12 = 180$ dakas of fodder per year. The price of 1 daka fodder is approximately 14.00 Birr. Converted to monetary value, 2520.00 Birr $i.e, (180 \times 14.00 Birr)$ fodder expense is incurred by the pastoralist to herd the camel per year. Water and veterinary service expenses for camels were found to be almost zero. In addition, the salt transporters usually do not hire other peoples to help them in the salt transporting activities. One male adult person is enough to do the activity. Thus, there is no labor cost that the household incur while transporting salt. Therefore, the total net income that could be gained throughout the year from the camel's salt transportation service is $6206.40 Birr - 2520.00 Birr = 3686.40 Birr$.

This reveals that, the interest rate that could be collected from one year deposition of the money is 1023.24 Birr but the profit that could be obtained from the camel's salt transportation service is 3686.40 Birr. From this it can be concluded that, a particular household will be better off if it purchase camel and use it for salt transportation rather than saving its money in a bank and collect interest.

The Effect of Salt Transportation on the Maintenance of Camels

Transporting salt is supposed to be a very difficult task which can make the salt transporter feel very tired and affect the maintenance of the camels. Even if the expectation about the transporters found to be true, the opposite was observed about the camels. It was tried to ask some of the camel owners and focal persons about the effect of salt transportation on the maintenance of the camels. But they surprisingly answer that, "salt transportation doesn't

[3]One daka fodder is equal with 10 kilograms of fodder.

have any negative effect on the health and maintenance of camels. Rather they act like mad and abnormal if they stop the activity. Because, they feel healthy and strong only if they work." However, this doesn't mean that they need no leisure. Out of a month the 2 weeks are their working time and the next two weeks are their leisure time.

4.1.6 Employment Contribution of Camel Salt Transportation Service

The salt mine has created a full time and par time job opportunities for many individuals those who participate in the different salt trade value chain stages. The presence of the salt transporters is important for the presence of the other different salt trade value chain participants for which their livelihood depends on the salt mine. This is because:

1. If the salt transporters do not transport the salt from the mining area to the market, the salt miners and shapers will not have buyer for whom to sell their salt and; the salt store owners, even indirectly the wholesalers, retailers and the final consumers will not have supplier from whom to purchase a salt.
2. All the payments made to the salt miners, salt shapers and salt unloaders are covered by the salt transporters.

Having the importance of salt transporters for the other participants in mind, this study will try to calculate the number of livelihoods supported by the salt trade value chain. All of the value chain participants except the salt store owners and their employees are difficult to exactly quantify. Thus, approximate but minimum numbers will be calculated for each of the participants to know how much livelihoods are supported by the salt mine taking salt transporters as a core participants and as an engine of the trade value chain.

- ✓ In the salt mining area, there are more than 4000 full time individual workers those who mine the salt layers from the mine (miners) and those who shape the salt layers in to blocks (shapers).
- ✓ The number of salt transporters those who transport the salt from the mining area to the market is not exactly known. However, it was tried to approximately quantify them.
    - ➢ On average, 3000 camels do come to the market center from the mining area carrying salt per day. A particular salt transporter holds an average of 7 camels at a time to transport salt. The ratio of the number of camels per day to the

number of camels held by one transporter can give us the average number of transporters those who transport salt per day.

Thus, $\frac{3000}{7} = 429$ individuals per day and $429 \times 30 = 12870$ individuals per month do transport salt.

A particular transporter does transport salt for an average of 3 times a month. Hence, the average number of full time salt transporters is $\frac{12870}{3} = 4290$

- ✓ There are around 450 daily workers those who unload the salt from the camels' back, count and store it in the store, and heap the salt on a car when a wholesaler come to purchase salt to the store
- ✓ The salt store which serves as a market in which the salt transporters sell their salt is owned by around 4234 individual shareholders and have 34 employed workers. All the shareholders are residents of the woreda. The store owners purchase the salt from the salt transporters and sell it to wholesalers.
- ✓ The wholesalers are individual traders those who sell the salt to retailers in bulk. There are around 150 wholesalers in which almost all of them came from Mekelle each having 1 driver of their car.
- ✓ The number of the retailers is difficult to quantify because they are too many.

In general, camel transportation service has created direct full time job opportunity for 4290 salt transporters and indirect full time job opportunities for 4000 salt miners and shapers, 4234 salt store owners with their 34 workers and 450 unloaders excluding the wholesalers and retailers since they are not directly chained to the salt transporters. Thus, a total of 13008 livelihoods are supported from the salt mine due to the presence and worthy contribution of camel transportation service.

4.1.7 The Contribution of Camel Salt Transportation Service for the National Economy

Tax is the major source of revenue for government of the country. Any resident of the country pay tax for the income s/he earns. The transporters also pay salt tax for the government for each salt block that they transport. They pay it before they go to the salt mining area. The amount of salt tax, that an individual salt transporter pays, depends on the number and size of the camels that he takes to the salt mine. The tax is levied per camel and its amount is 13.00 Birr, 17.00 Birr and 22.00 Birr per a young, medium and adult camel respectively.

- An average of 3000 camels of salt is transported from the mining area to the market per day in the 8 salt mining months (from Middle of September up to Middle of May). Out of the 3000 daily camels, the proportion of the young, medium and adult camels is approximately similar (1000 each) even if it is not exactly known. This indicates, an average of:
  - ✓ 13.00 Birr * 1000 + 17.00 Birr * 1000 + 22.00 Birr * 1000 = 52,000.00 Birr per day,
  - ✓ 52,000.00 Birr * 30 = 1,560,000.00 Birr per month, and
  - ✓ 1,560,000.00 Birr * 8 = **12,480,000.00 Birr** per year salt tax is collected from the salt transporters by the government which reveal the direct and worthy contribution of camel salt transportation service for the national economy.

4.2 Econometric Analysis

In this part, econometric method of data analysis is used to estimate the impact of camel ownership on household livelihoods: household income, livestock holdings and fixed asset formation using propensity score matching (PSM). Accordingly, the first stage, the logistic regression model, is used to estimate the determinant factors those affect households' camel ownership and the second stage, to estimate the impact of camel salt transportation service on livelihoods of camel owner pastoral households using the different average treatment effect for the treated (ATT) estimation algorithms. And finally, the variables those affect camel rent decision of the camel owners are identified using ordered probit regression model. Stata version 12.1 was used to make all these estimations.

Before running the models, problem of multicollinearity was checked and results fall below the rule of thumb level of 0.8 (Gujarati, 2004). The correlation between adumale and adulthh is >0.8 but the variables are not used in the same model. The correlation matrix of the variables is presented in *Annex V*.

4.2.1 Propensity Score Estimates

Logistic estimation model was used to estimate the propensity scores to match the outcomes of interest of the camel owner households with the non-owners. Then, the estimated propensity scores of the logistic regression help to match the two groups of households. The estimation results of the logit model are presented in *Annex VI*.

Furthermore, coefficients, odds ratios, marginal effects, standard errors and associated p-values of the independent variables used in the logistic regression are presented in *Table 4.5* below. The result shows that, 247 observations out of the total 250 are used in the analysis, indicating the 3 observations constitute variables with missing values. The logit regression gave a Pseudo (McFadden) R–squared of about 0.2408 which implies that all the independent variables included in the model do explain about 24 percent of the probability of households' camel ownership. The overall model is statistically significant at a P-value of 0.0000. The model was also checked for model specification problem via linktest and the result of the test implies the model is correctly specified.

The estimation results also show that the balancing property was satisfied and the common support region for the propensity score of the sample households was [.092 , .957]. This indicates that, the propensity scores of the camel non-owner households below .092 and of camel owner pastoral households above .957 is excluded and the balancing property is satisfied with in this region.

Interpretation of the coefficients

Independent variables used in the logistic regression are: sex, age and literacy of the household head, access to credit, camel ownership of parents of the household head, number of adult members in the household and adult ratio for the household. The estimated marginal effect coefficients of all of the variables, except access to credit and adult ratio for the household, provide strong evidence about their effect on the likelihood of households' camel ownership.

Sex of the household head is one of the determinant factors those affect the likelihood of households' camel ownership. The marginal effect coefficient of this variable has a positive sign as it was expected and is statistically significant at 5% level of significance. The marginal effect implies, the likelihood of camel ownership of male headed households is 28.3 percent higher than the female headed households holding other variables in the model constant. In short, being male headed household increases the likelihood of camel ownership by 28.3 percent.

Another influential variable of households' camel ownership is *age of the household head*. The variable has statistically significant (at 10% level of significance) and negative marginal effect coefficient. This resultant marginal effect shows that, a one year increase in the age of

the household head decreases the likelihood of the household's camel ownership by 1.1 percent, keeping the other variables constant. This is in line with the fact that, young household heads are more likely to own camels than the elders due to their better capability of herding camels and elder household heads do distribute their camels among their married children.

Literacy of the household head is also another determinant factor for the household to be camel owner or not. As a result of the logit regression, the marginal effect coefficient of the variable was found having negative sign and statistical significance at 5% level of significance. The marginal effect tells us that, being literate decreases the likelihood of owning camels by 18.1% ceteris paribus. This is because, literate household heads do prefer to be employed for wage rather than doing fatiguing activities such as camel production.

Camel ownership of parents of the household head is also found to be one of the decisive factors for a household to own camels or not. The marginal effect coefficient of this variable is positive and statistically significant even at 1% level of significance. The marginal effect implies that, household heads with camel owner pastoralist parents do have 56.4 percent higher likelihood of camel ownership than the household heads with camel non-owner parents, keeping other variables constant.

The other independent variable which affects the likelihood of households' camel ownership is *the number of adult members in a household*. The variable has statistically significant (at 5% level of significance) and positive marginal effect coefficient. The magnitude and sign of the marginal effect shows that, a one unit increase in the number of adult members in a household increases the camel ownership likelihood of the household by 7.9 percent, holding other variables constant.

In general, male headed households, households with young and illiterate household heads, household heads with camel owner pastoralist parents, and households with large number of adult members do have better likelihood of camel ownership than their counterparts.

Table 4.5 Logistic estimation results for the likelihood of households' camel ownership

Variables	Coef.	Odds Ratio	P>|z|	dy/dx	P>|z|
Sexhh	1.304	3.685**	0.047	.283^	0.011
	(.657)	(2.419)		(.112)	
Agehh	-.044	.957*	0.080	-.011	0.080
	(.025)	(.024)		(.006)	
Educhh	-.755	.470**	0.054	-.181^	0.041
	(.392)	(.184)		(.089)	
acc_credit	.277	1.320	0.496	.069^	0.495
	(.407)	(.537)		(.101)	
famexp_co	2.613	13.64***	0.000	.564^	0.000
	(.364)	(4.96)		(.056)	
Adulthh	.317	1.373**	0.041	.079	0.041
	(.155)	(.213)		(.039)	
adul_ratio	-.324	.723	0.140	-.081	0.139
	(.219)	(.159)		(.055)	
_cons	-.916		0.303		
	(.889)				
Number of obs = 247				Maximum Likelihood R2: 0.283	
LR chi2(7) = 82.03				McFadden's Adj R2: 0.194	
Prob > chi2 = 0.0000				AIC: 1.112	
Pseudo R2 = 0.2408				BIC: -1058.148	
McKelvey and Zavoina's R2: 0.367				BIC': -43.466	

*, ** and *** Significant at **10%, 5%** and **1%** levels respectively
(^) dy/dx is for discrete change of dummy variable from 0 to 1
Figures in parentheses are the ***Standard Errors***

Source: Own Survey, 2013

4.2.2 Impact Estimates

Based on the logistic estimation results, camel owners and non-owners were compared using livelihood indicators: income, livestock ownership and fixed asset formation. The camel salt transportation service was intended to bring about a change in the fixed asset formation and livestock ownership of the camel owner pastoral households, in addition to its contribution to their income earning.

To check how robust and sensitive our estimates are to the different matching functional forms, four different matching algorithms have been estimated and results were found to be quantitatively as well as qualitatively similar, which shows the robustness of the results.

Hence, the four different matching algorithms: nearest neighbour, stratification, radius and kernel, are used in order to estimate the livelihood effect of camel ownership on the camel owner pastoral households.

Nearest neighbour matching (NNM), which is one of the four matching algorithms, can be estimated either with or without weights. But, since estimating average treatment effect using NNM with or without weights does not affect the results (Khandker, n.d), the nearest neighbour estimation results for each of the livelihood indicators in this analysis are without weights. In addition, the "reps" option used in the kernel matching method performs the bootstrapping 50 times.

The ATT estimation results of each of the matching algorithms for income, livestock ownership and fixed asset value of households are presented in *Annex VII, Annex VIII* and *Annex IX* respectively.

Impact on Income of Households

The ATT results and their respective t-value for income of households using the four matching methods are presented in *Table 4.6* below.

Table 4.6 ATT results for income of households

Matching Algorithm	**No. Treated**	**No. Control**	**ATT**	**Std. Err**	**t-value**
Nearest Neighbour	113	62	12677.8	5602.9	2.263**
Stratification	113	131	11312.4	6214.1	1.820*
Radius	113	131	10393.2	5566.3	1.867*
Kernel	113	131	11440.7	5997.9	1.907*

Source: Own Survey, 2013

The estimation result shows a significant impact of camel ownership, particularly camel salt transportation service, on income of the camel owner pastoral households. The nearest-neighbour, stratification, radius and kernel matching methods provide ATT values of

12677.80 Birr, 11312.40 Birr, 10393.20 Birr and 11440.70 Birr with a respective t-value of 2.263, 1.820, 1.867 and 1.907. Hence, since all of the four matching algorithms are consistent with positive and statistically significant ATTs, the result is recognized as a reliable.

Impact on Livestock Ownership (TLU) of Households

The ATT results and their respective t-value for the livestock ownership of households using the four matching methods are presented in *Table 4.7* below.

Table 4.7 ATT results for TLU of households

Matching Algorithm	**No. Treated**	**No. Control**	**ATT**	**Std. Err**	**t-value**
Nearest Neighbour	113	62	6.5	0.63	10.392***
Stratification	113	131	6.7	0.59	11.174***
Radius	113	131	6.8	0.58	11.622***
Kernel	113	131	6.6	0.64	10.351***

Source: Own Survey, 2013

Camel ownership and its salt transportation service is expected to increase household's capability of purchasing livestock via its income effect. Hence, TLU value of the camel owner pastoral households is expected to be higher than the non-owners. The results presented in the table above are also in line with the expectation. The estimated ATTs on TLU value of the nearest-neighbour, stratification, radius and kernel matching methods are 6.5, 6.7, 6.8 and 6.6 respectively with corresponding t-values of 10.392, 11.174, 11.622 and 10.351. All the t-values are statistically significant even at 1% level of significance. This shows a clear difference in livestock ownership between the treated and untreated households.

Impact on Fixed Asset Value of Households

The asset value of the total sample households is averaged to 36026.00 Birr per household with minimum and maximum extremes of 0.00 and 791,400.00 Birr respectively. Since the asset values are bouncing between two extreme amounts, hence, log-transformed fixed asset value (lnass_value) is used as an outcome variable for the matching.

The ATT results and their respective t-value for the fixed asset value of households using the four matching methods are presented in *Table 4.8* below.

Table 4.8 ATT results for fixed asset value of households

Matching Algorithm	**No. Treated**	**No. Control**	**ATT**	**Std. Err**	**t-value**
Nearest Neighbour	113	62	0.02	0.27	0.072
Stratification	113	131	0.01	0.19	0.033
Radius	89	130	0.06	0.14	0.41
Kernel	113	131	0.03	0.16	0.182

Source: Own Survey, 2013

Neither of the ATT estimation results of the four matching algorithms do have a statistical significance. The results imply that, there is no as such significant difference between the camel owner and non-owner groups of households in the value of their fixed asset ownership. From this, it can be concluded that, camel ownership doesn't have any impact on the fixed asset formation of households.

From the focus group discussions it was also understood that, we couldn't get difference in fixed asset formation between the two groups of households because the peoples of the study area are pastoralists those who share all what they have between each other which doesn't enable the higher income earner camel owners to form more fixed asset since they share their income with the lower income earners. Due to their sharing culture all residents of the woreda lead similar standard of living.

4.2.3 Estimation Results of the Sensitivity Analysis

Table 4.9: Simulation-Based Sensitivity Analysis Results

Matching Algorithm	***Livelihoods Indicator***	***Baseline ATT***	***Simulated ATT***	***Std. Err.***	***d***	***Outcome Effect***	***s***	***Selection Effect***
Nearest-Neighbor	incomehh	12677.8	12554.9	8261.7	0.2	4.2	0.2	5.4
	tlu	6.5	6.5	0.8	0.25	4.0	0.32	5.9
Kernel	incomehh	11440.7	10452.8	.	0.1	1.96	0.2	3.5
	tlu	6.6	5.9	.	0.5	17.4	0.59	60.6
Radius	incomehh	10386.7	10255.0	5552.5	0.05	1.4	0.33	7.7
	tlu	6.8	6.5	0.6	0.4	10.6	0.5	17.0

Sensitivity analysis has been undertaken only for two of the livelihood indicators: income and livestock ownership using three matching algorithms: nearest-neighbour, kernel and radius, since the *ATT* results of the fixed asset formation are insignificant. The results of the three matching methods in two of the livelihood indicators are consistent. As it is shown in the table, even though U is associated to very large selection ($\Gamma>1$) and outcome effects ($\Lambda>1$) for each of the matching algorithms, the simulated *ATT* of each of the livelihood indicators is very close to the baseline estimate. This implies that, it is only when U is simulated to provide implausibly large outcome effect; the *ATT* can be driven far from the baseline or closer to zero.

Hence, in general, it can be concluded that, the results of the analysis support the robustness of the matching estimates.

4.2.4 Estimation Results and Discussions of the Ordered Probit Model

A camel owner pastoral household has three alternative ordered possible responses regarding its experience on camel rent. It may have “never” been rented out its camels or “sometimes” renting out and sometimes not, or “always” rented out its camels for other salt transporters taking values of “1”, “2” and “3” in the analysis respectively. Having this three level variable, an ordered probit model was used to estimate the effects of the independent variables that are expected to affect the response variable. The response variable is households’ camel rent decision and the independent variables used as predictors are: age and literacy of the household head, number of adult male members in the household, access to credit of the household, income of the household and number of camels owned by the household. Furthermore, the model was checked for model specification via linktest and the result of the test implies the model is correctly specified.

The estimation results obtained from the ordered probit model are presented in *Annex XI*. Moreover, coefficients, marginal effects, standard errors and associated p-values of the independent variables used in the model are presented in *Table 4.10* below.

Table 4.10 Ordered probit estimation results for the households' camel rent decision

Variables	Coef.	P>|z|	dy/dx	P>|z|
agehh	-.015	0.385	-.004	0.386
	(.017)		(.005)	
educhh	.523*	0.075	.170^	0.098
	(.294)		(.104)	
adumale	-.210	0.148	-.061	0.150
	(.145)		(.042)	
acc_credit	-.221	0.480	-.061^	0.449
	(.312)		(.080)	
incomehh	-9.67e-07	0.654	-2.80e-07	0.656
	(2.16e-06)		(.000)	
camels_hh	-.111***	0.002	-.032	0.003
	(.036)		(.011)	
Number of obs = 115				
Wald chi2 (6) = 32.01				
Prob > chi2 = 0.0000				
Pseudo R2 = 0.1343				

*, ** and *** Significant at **10%, 5%** and **1%** levels respectively
(^) dy/dx is for discrete change of dummy variable from 0 to 1
Figures in parentheses are ***Standard Errors***

Source: Own Survey, 2013

The estimation result tells us that, all the 115 observations in our data set are used in the analysis. The Wald chi-square of 32.01 with a p-value of 0.0000 also shows the model as a whole is statistically significant.

Interpretation of the Coefficients

Literacy of the household head and number of camels owned by the household are the only two variables with a significant effect on households' camel rent decision. The effect of the other four variables used in the model was found to be insignificant.

Literacy of the household head: - The marginal effect coefficient of this variable is positive and statistically significant at 10% level of significance. A marginal effect of .170 implies that, literate camel owner household heads are 17 percentage points more likely to always rent out their camels for other salt transporters given all the other variables in the model are

held constant. This is because; literate household heads can have better opportunity to be employed for wage depending on their level of education especially if they are highly literate. This motivates them not to participate in salt transportation and to always rent out their camels due to shortage of time that they face and the fatigue nature of salt transportation activities. Hence, it can be concluded that, literate household heads do more likely rent out their camels than those who are illiterate.

Number of camels owned by the household: This variable has a negative and significant (even at 1% level of significance) effect on households' camel rent decision. The marginal effect coefficient of the variable implies that, a one unit increase in the number of camels owned by a household decreases the likelihood of always renting out camels for other salt transporters by 3.2 percentage points keeping the other variables used in the model constant. This means that, if a particular household head holds only few camels, he/she prefers to rent out them to other salt transporters rather than transporting salt by oneself but having much number of camels make the household head's decision tend to transport salt by oneself rather than renting out camels to others.

The observed factor for this is that, the minimum number of camels that the salt transporters usually take to the salt mining area for transportation is 4 camels. This number is taken as a minimum threshold for profitability and for the transporter to feel that they are much enough to transport salt. Thus, a household holding camels fewer than this minimum threshold has two choices; to rent out them for other salt transporters or rented in additional camels and transport salt by oneself holding the other characteristics of the household constant.

CHAPTER FIVE

5. CONCLUSIONS AND POLICY RECOMMENDATIONS

5.1 Conclusions

Of the different transportation services that a camel provides, this study offers some evidence about the camel salt transportation service from the salt mine to the market and its impact on the livelihood of the camel owner pastoral households in Berahle woreda of Afar regional state of Ethiopia. A cross sectional primary data collected from 250 sample households (including 115 camel owners and 135 camel non-owners) was used for analysis in the study. In addition, the results obtained were validated and complemented with qualitative data collected from the FGDs carried out. Propensity score matching (PSM) method was employed to capture the livelihood contribution of camel salt transportation service for the camel owner pastoral households in the study area. In the first stage of the matching, logit regression model was used to model the probability of camel ownership. The logistic estimation result shows that, the main determinant factors which positively affect the likelihood of households' camel ownership are: sex of the household head, camel ownership of the parents of the household head and number of adult members in the household. On the contrary, age and literacy of the household head do negatively and significantly affect households' likelihood of camel ownership. In the second stage, four matching algorithms (Nearest-Neighbour, Kernel, Radius and Stratification) were used to estimate the livelihood difference between the camel owner and non-owner households. Income, livestock ownership and fixed asset value of the households were used as livelihood indicators for the comparison. The result of the different matching algorithms, even after controlling for household characteristics that may influence outcomes of the households, was consistent which shows their robustness. The estimation results show a positive and significant difference in two of the livelihood indicators i.e., income and livestock ownership between the two groups of households. On the other hand, the effect of camel ownership on fixed asset value is insignificant which shows similarity between the higher income earner camel owners and the lower income earner camel non-owners in their fixed asset formation. In general, livelihood was significantly higher among the camel owner pastoral households than the camel non-owner households.

The study has also tried to identify the main determinant factors which affect camel rent decision of the camel owner pastoral households using ordered probit regression model. The households were categorized in to three groups in terms of their response about their experience on camel rent; those who “always”, those who “sometimes” and those who have “never” been rented out their camels for other salt transporters. From the ordinal estimation, only literacy of the household head and number of camels owned by the household were found to be the highly influential factors determining a particular household head whether to rent out his/her camels or not. The coefficients of these variables are statistically significant with respective positive and negative effects on the likelihood of renting out camels.

Another focus of the study was, identifying the main beneficiaries of the salt mine and calculating the profit proportion of the salt transporters among the total profit of the salt trade value chain participants, by undertaking cost benefit analysis of each participant using descriptive analysis. The major salt trade value chain participants are: salt miners (those who extract the salt layers from the salt mine), salt shapers (those who shape the salt layers in to blocks; and heap and pack the salt blocks atop of camels), salt transporters (those who transport the salt from the salt mine to the market), salt unloaders (those who unload, count and store the salt in the store which serve as a market), owners of the store (those who purchase the salt from salt transporters and sale it to wholesalers), wholesalers (those who purchase the salt from the store owners and sale it to retailers) and retailers (those who retail the salt to the final consumers). Of all these salt trade value chain participants, the highest benefit goes to the salt transporters with profit percentage share of 41.9 percent.

The study has also tried to investigate the contribution of camels’ salt transportation service for employment and for the national economy. Thus, the service of the camels was found to be a reason for employment of 13008 individuals and contributes around 12,480,000.00 Birr annually for the national economy in the form of salt tax. This reveals the direct and worthy contribution of camel salt transportation service for the society in particular and for the national economy in general.

In general, it can be concluded that, camel ownership and participation of the camel owner pastoral households in the salt trade value chain by transporting salt has a positive impact on their livelihoods by increasing their income and livestock ownership.

5.2 Policy Recommendations

Camels play an important role to the livelihood and survival of the pastoral households and employment of many individuals in the study area; and the national economy in general. However, there are different identified factors in the area which affect the number and productivity of camels; and the salt trade participation of the camel owner pastoral households which indirectly affects their livelihoods. Many camel owner pastoral households have evidenced as the number of their camels is decreasing over time due to different factors. The stated frequent causes of loss of camels in the area are recurrent drought (shortage of food and water), disease that causes death and rustling. The first cause could be somehow difficult for avoidance due to its nature but could be reduced. However, with a maximum effort, the other two factors could be avoided. The second cause of camel loss suggests that, a due concern is needed to enhance the livelihood of the pastoralists by providing disease prevalence strategies such as providing improved access to veterinary services. As far as the rustling problem that the salt transporters face while at journey is concerned, even if the problem is decreasing over time due to the security services that the government is providing them, since it is not totally avoided and for the sustainability of the security, it is recommended that the existing security be strengthened and sustained. As a result, optimal production is anticipated to be ensured.

In addition, despite the fact that the salts mine had a worthy impact on the livelihoods of the salt trade value chain participants, the mining area is managed and administered by custom law of the society. There is no any legal law prepared by the government for the administration of the area. However, government has to give a keen focus to intervene in administrating the area for the sake of an efficient use of the resource.

Furthermore, unequal distribution of the gain from the salts mine among the salt trade value chain participants was observed. All the groups of individuals in each stage of the value chain are not equally profitable from the salt trade. Hence, some effort of making some arrangements has to be imposed by the government and other concerned bodies to help the benefit from the salt be fairly distributed among the different value chain participants.

In this study, the impact estimation of camel ownership on the livelihoods of camel owner pastoral households shows that, the camel owner pastoral households have better income and livestock ownership than the camel non-owners which could make them to be capable of

forming relatively higher fixed assets. However, an insignificant difference was found in the fixed asset formation between the two groups of households. This indicates that, awareness creation regarding money management and fixed asset formation is desirable among the camel owner pastoral households which are less likely educated than those who are non-owners. To solve this problem, government organizations and concerned bodies are expected to prepare some awareness creation strategies.

In general, any national policy or development intervention aimed at improving the welfare of pastoral societies should take into account the worthy social and economic contribution of camels particularly their transportation service and the previously stated problems in the study area.

5.3 Suggestions for Further Research

In addition to their salt transportation service, camels are also the major means of transporting household tools when the nomadic pastoralists found around the study area move from one area of residence to another following weather condition. This contribution of camels' transportation service for the nomadic pastoralists has also to be valued which demand further investigation and should be addressed in future researches, since it is outside the scope of this paper.

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Annexes

Annex I

Description of Variables Used for Analysis in the Study

Treatment Variable		
camel_ownp	Households' camel ownership	Dummy (1= Camel owner, 0=Camel non-owner)
Livelihood Indicators		
incomehh	Annual income of a household	Continuous (ETB)
tlu	Tropical livestock unit of a household	Continuous (TLU)
ass_value	Value of fixed assets for a household	Continuous (ETB)
Decision Variable		
cmlrent_dec	Camel owner pastoral households' camel rent decision	Ordered (1=Never, 2=Sometimes, 3=Always)
Independent Variables		
sexhh	Sex of the household head	Dummy (1=Male, 0=Female)
agehh	Age of the household head	Continuous (Number of years)
educhh	Literacy of the household head	Dummy (1=Literate, 0=Illiterate)
maritalhh	Marital status of the household head	Dummy (1=Married, 0=Unmarried)
hhsize	Household size	Continuous (Number)

adulteqival	Adult equivalence for the household	Continuous (Number)
adulthh	Number of adult members in the household	Continuous (Number)
adumale	Number of male adult members in the household	Continuous (Number)
adul_ratio	Adult ratio for the household	Continuous (Number)
depratio	Dependency ratio for the household	Continuous (Number)
acc_credit	Access to credit	Dummy (1=Yes, 0=No)
locins_memp	Local institution membership	Dummy (1=Yes, 0=No)
extser_part	Extension service participation	Dummy (1=Yes, 0=No)
acc_water	Access to drinking water	Dummy (1=Yes, 0=No)
acc_electr	Access to electricity	Dummy (1=Yes, 0=No)
resid_type	Households' residence type	Dummy (1=Permanent, 0=Temporary/Movable)
pastor_hh	Whether the household is pastoralist or not	Dummy (1=Pastoralist, 0=Other)
empt_wage	Employment for wage (Whether any member of the household has employed for wage in 2012/13 or not)	Dummy (1=Yes, 0=No)
own_buss	Own business activity (Whether any member of the household has carried out own business activities in 2012/13 or not)	Dummy (1=Yes, 0=No)
migration	Migration to other places (Whether any member of the household has migrated to other place seeking a job in 2012/13 or not)	Dummy (1=Yes, 0=No)
by-product	Sale of livestock by-products (Whether the household has	Dummy (1=Yes, 0=No)

	sold any livestock by-products in 2012/13 or not)	
famexp_co	Camel ownership of parents of the household head	Dummy (1=Yes, 0=No)
camels_hh	Number of camels owned by the household	Continuous (Number)
cmls_gift	Whether the household has camels received as a gift among its present holdings or not	Dummy (1=Yes, 0=No)
cmls_overtime	Status of the households' camel holdings overtime	Categorical (1=Increasing, 2=Constant, 3=Decreasing)
salttrans_exp	Households' salt transportation experience	Dummy (1=Yes, 0=No)
cmlrent_exp	Households' camel rent experience	Dummy (1=Yes, 0=No)
yrs_salttrans	Number of years the household head spent in salt transportation	Continuous (Number of years)
yrs_cmlrent	Number of years the household head spent in renting out his/her camels for other salt transporters	Continuous (Number of years)
yrs_cmlprod	Number of years the household head spent in camel production	Continuous (Number of years)
cml_relevance	The relevance of camel transportation service for day to day activities and livelihood of pastoralists in the study area	Categorical (1=Strongly agree, 2=Agree, 3=No opinion, 4=Disagree, 5=Strongly disagree)

Annex II

Adult Equivalence (AE) Conversion Factors

Age group (Years)	Male	Female
< 10	0.60	0.60
10 -13	0.90	0.80
14 -16	1.0	0.75
17-50	1.0	0.75
> 50	1.0	0.75

Source: Storck et al. (1991)

Annex III

Conversion Factors Used to Estimate Tropical Livestock Unit (TLU)

Livestock Type	TLU (Tropical Livestock Unit)
Camel	1.25
Horse	1.10
Oxen	1.00
Cow	1.00
Heifer	0.75
Calf	0.25
Donkey (Adult)	0.70
Donkey (Young)	0.35
Sheep and Goat (Adult)	0.13
Sheep and Goat (Young)	0.06
Chicken	0.013

Source: Storck et al. (1991)

Annex IV

Summary Statistics of Variables Used for Analysis in the Study

	For full sample					For camel owners					For camel non-owners				
Variable	Obs.	Mean	Std. Dev.	Min	Max	Obs.	Mean	Std. Dev.	Min	Max	Obs.	Mean	Std. Dev.	Min	Max
camel_ownp	250	.46	.4993972	0	1	115	1	0	1	1	135	0	0	0	0
incomehh	250	29883.62	37275.99	0	395700	115	35984.92	42423.52	1200	395700	135	24686.21	31491.01	0	172800
Tlu	250	4.97452	5.043615	0	29.6	115	8.642	5.182113	1.51	29.6	135	1.85037	1.745455	0	7.85
ass_value	250	36026.2	57752.82	0	791400	115	32410.17	27361.99	3000	185400	135	39106.52	74432.06	0	791400
cmlrent_dec	115	1.669565	.8555468	1	3	115	1.669565	.8555468	1	3	0				
Sexhh	250	.92	.2718374	0	1	115	.9478261	.2233508	0	1	135	.8962963	.3060113	0	1
Agehh	250	37.296	8.536267	20	68	115	37.49565	8.351252	24	68	135	37.12593	8.718166	20	65
educhh	250	.24	.4279399	0	1	115	.173913	.3806935	0	1	135	.2962963	.4583239	0	1
maritalhh	250	.956	.2055065	0	1	115	.9652174	.1840306	0	1	135	.9481481	.2225537	0	1
hhsize	250	4.752	1.529659	1	10	115	5.026087	1.624704	1	10	135	4.518519	1.408142	1	7
adulteqival	250	4.05256	1.405304	1.04	10.24	115	4.286087	1.547013	1.04	10.24	135	3.85363	1.243792	1.04	7.08
adulthh	250	2.936	1.369454	1	8	115	3.034783	1.538571	1	8	135	2.851852	1.206441	1	7
adumale	250	1.592	.9492842	0	6	115	1.634783	.9852458	1	5	135	1.555556	.9196582	0	6
adul_ratio	247	1.297571	.7965902	0	6	113	1.235251	.6853981	.3333	4	134	1.350124	.8786417	0	6
depratio	250	.3649095	.2205407	0	.75	115	.3913561	.2083123	0	.75	135	.342381	.2288036	0	.7142857

acc_credit	250	.172	.3781375	0	1	115	.2	.4017506	0	1	135	.1481481	.3565699	0	1
locins_memp	250	.42	.4945486	0	1	115	.3217391	.4691879	0	1	135	.5037037	.5018484	0	1
extser_part	250	.636	.4821138	0	1	115	.573913	.4966708	0	1	135	.6888889	.4646724	0	1
acc_water	250	.74	.4395142	0	1	115	.7304348	.4456759	0	1	135	.7481481	.4356933	0	1
acc_electr	250	.724	.4479135	0	1	115	.6869565	.4657614	0	1	135	.7555556	.4313579	0	1
resid_type	250	.804	.3977648	0	1	115	.7826087	.4142761	0	1	135	.8222222	.3837495	0	1
pastor_hh	250	.912	.2838632	0	1	115	1	0	1	1	135	.837037	.3707074	0	1
empt_wage	250	.472	.5002168	0	1	115	.3478261	.4783649	0	1	135	.5777778	.4957531	0	1
own_buss	250	.524	.5004255	0	1	115	.6782609	.4691879	0	1	135	.3925926	.4901461	0	1
migration	250	.028	.1653037	0	1	115	.026087	.1600915	0	1	135	.0296296	.1701948	0	1
by-product	250	.304	.4609053	0	1	115	.2608696	.4410306	0	1	135	.3407407	.4757235	0	1
famexp_co	250	.32	.4674119	0	1	115	.5826087	.4952867	0	1	135	.0962963	.2960958	0	1
camels_hh	250	2.628	3.713864	0	20	115	5.713043	3.513795	1	20	135	0	0	0	0
cmls_gift	115	.3130435	.4657614	0	1	115	.3130435	.4657614	0	1	0				
cmls_overtime	115	2.278261	.755655	1	3	115	2.278261	.755655	1	3	0				
salttrans_exp	250	.344	.475994	0	1	115	.7478261	.436161	0	1	135	0	0	0	0
cmlrent_exp	250	.192	.3946632	0	1	115	.4173913	.4952867	0	1	135	0	0	0	0
yrs_salttrans	250	3.816	7.076613	0	42	115	8.295652	8.479049	0	42	135	0	0	0	0
yrs_cmlrent	250	1.66	4.531062	0	35	115	3.608696	6.144025	0	35	135	0	0	0	0
yrs_cmlprod	250	8.228	11.59767	0	50	115	17.88696	10.93182	1	50	135	0	0	0	0
cml_relevance	250	1.732	.8804982	1	4	115	1.278261	.4501038	1	2	135	2.118519	.9700889	1	4

Source: Own Computation, 2013

Annex V

Correlation Matrix

```
. corr sexhh agehh educhh acc_credit famexp_co camels_hh adulthh adumale adul_ratio incomehh
(obs=247)
```

	sexhh	agehh	educhh	acc_cr~t	famexp~o	camels~h	adulthh	adumale	adul_r~o	incomehh
sexhh	1.0000									
agehh	0.1646	1.0000								
educhh	0.0989	-0.2664	1.0000							
acc_credit	0.0580	0.1032	-0.0111	1.0000						
famexp_co	0.0101	0.0403	-0.1005	0.0786	1.0000					
camels_hh	0.1181	0.0692	-0.1392	0.0512	0.4601	1.0000				
adulthh	0.0557	0.6379	-0.2240	0.0228	0.0030	0.2058	1.0000			
adumale	0.0765	0.5916	-0.2055	0.0158	0.0053	0.1682	0.8639	1.0000		
adul_ratio	0.0395	0.3470	-0.1141	0.0050	-0.0242	0.0015	0.3661	0.7491	1.0000	
incomehh	0.0609	0.0538	0.0397	0.0853	0.0627	0.2584	0.1459	0.0373	-0.1013	1.0000

Annex VI

Logistic Estimation Results for Households' Camel Ownership

```
. pscore camel_ownp sexhh agehh educhh acc_credit famexp_co adulthh adul_ratio,
pscore(cpscore) blockid(cblock) comsup logit

**************************************************
Algorithm to estimate the propensity score
**************************************************
The treatment is camel_ownp

Households' |
      camel |
  ownership |       Freq.     Percent        Cum.
------------+-----------------------------------
         no |        135       54.00       54.00
        yes |        115       46.00      100.00
------------+-----------------------------------
      Total |        250      100.00
```

Estimation of the propensity score

```
Iteration 0:   log likelihood = -170.31356
Iteration 1:   log likelihood = -130.58844
Iteration 2:   log likelihood = -129.31571
Iteration 3:   log likelihood = -129.29781
Iteration 4:   log likelihood = -129.29781
```

Logistic regression

```
                                                  Number of obs   =        247
                                                  LR chi2(7)      =      82.03
                                                  Prob > chi2     =     0.0000
Log likelihood = -129.29781                       Pseudo R2       =     0.2408
------------------------------------------------------------------------------
  camel_ownp |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       sexhh |   1.304224   .6565441     1.99   0.047     .0174212    2.591027
       agehh |  -.0440301    .025171    -1.75   0.080    -.0933644    .0053043
      educhh |  -.7551214   .3923199    -1.92   0.054    -1.524054    .0138116
  acc_credit |    .277352   .4070258     0.68   0.496     -.520404    1.075108
   famexp_co |   2.612723   .3637453     7.18   0.000     1.899795    3.325651
     adulthh |    .316666   .1551088     2.04   0.041     .0126582    .6206738
  adul_ratio |  -.3242035   .2194498    -1.48   0.140    -.7543171    .1059102
       _cons |  -.9158102   .8893005    -1.03   0.303    -2.658807    .8271869
------------------------------------------------------------------------------
```

Note: the common support option has been selected
The region of common support is [.09217514, .95676133]

```
Description of the estimated propensity score
in region of common support

                 Estimated propensity score
-------------------------------------------------------------
      Percentiles      Smallest
 1%      .098407       .0921751
 5%     .1377795       .0959263
10%     .1681731        .098407       Obs                 244
25%     .2401751        .098407       Sum of Wgt.         244
50%      .359087                      Mean           .4624052
                        Largest       Std. Dev.      .2730841
75%     .7935563        .931319
90%      .874327       .9422759       Variance       .0745749
95%     .8886895       .9459038       Skewness       .5108862
99%     .9422759       .9567613       Kurtosis       1.683815
*******************************************************
Step 1: Identification of the optimal number of blocks
Use option detail if you want more detailed output
*******************************************************
The final number of blocks is 5

This number of blocks ensures that the mean propensity score
is not different for treated and controls in each blocks

*********************************************************
Step 2: Test of balancing property of the propensity score
Use option detail if you want more detailed output
*********************************************************
```

The balancing property is satisfied

```
This table shows the inferior bound, the number of treated
and the number of controls for each block

  Inferior |   Households' camel
  of block |     ownership
of pscore  |        no        yes |     Total
-----------+----------------------+----------
  .0921751 |        31          7 |        38
        .2 |        70         28 |        98
        .4 |        18         13 |        31
        .6 |         5         14 |        19
        .8 |         7         51 |        58
-----------+----------------------+----------
     Total |       131        113 |       244

Note: the common support option has been selected
*******************************************
End of the algorithm to estimate the pscore
*******************************************
```

. logit, or

```
Logistic regression                               Number of obs   =        247
                                                  LR chi2(7)      =      82.03
                                                  Prob > chi2     =     0.0000
Log likelihood = -129.29781                       Pseudo R2       =     0.2408
------------------------------------------------------------------------------
  camel_ownp | Odds Ratio   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       sexhh |   3.684828   2.419252     1.99   0.047     1.017574    13.34347
       agehh |   .9569252   .0240868    -1.75   0.080     .9108616    1.005318
      educhh |   .4699536   .1843722    -1.92   0.054      .217827    1.013907
  acc_credit |   1.319631   .5371238     0.68   0.496     .5942804    2.930309
   famexp_co |   13.63613   4.960078     7.18   0.000     6.684526    27.81709
     adulthh |   1.372544   .2128937     2.04   0.041     1.012739    1.860181
  adul_ratio |   .7231031   .1586848    -1.48   0.140     .4703317    1.111722
------------------------------------------------------------------------------
```

```
. mfx
```

Marginal effects after logit

```
      y  = Pr(camel_ownp) (predict)
         =   .4620201
------------------------------------------------------------------------------
variable |      dy/dx    Std. Err.     z    P>|z|  [    95% C.I.   ]      X
---------+--------------------------------------------------------------------
   sexhh*|   .2826158      .11169    2.53   0.011   .063707  .501525   .919028
   agehh |   -.010944      .00625   -1.75   0.080  -.023197  .001309    37.251
  educhh*|  -.1812698      .08892   -2.04   0.041  -.355551 -.006989   .242915
acc_cr~t*|   .0691613      .10145    0.68   0.495  -.129684  .268007   .174089
famexp~o*|   .5634823      .05625   10.02   0.000   .453226  .673738   .315789
 adulthh |   .0787097      .03853    2.04   0.041   .003187  .154232   2.95547
adul_r~o |  -.0805832      .05452   -1.48   0.139  -.187444  .026277   1.29757
------------------------------------------------------------------------------
(*) dy/dx is for discrete change of dummy variable from 0 to 1
```

. fitstat

```
Measures of Fit for logit of camel_ownp

Log-Lik Intercept Only:     -170.314     Log-Lik Full Model:         -129.298
D(239):                      258.596     LR(7):                        82.032
                                         Prob > LR:                     0.000
McFadden's R2:                 0.241     McFadden's Adj R2:             0.194
Maximum Likelihood R2:         0.283     Cragg & Uhler's R2:            0.378
McKelvey and Zavoina's R2:     0.367     Efron's R2:                    0.306
Variance of y*:                5.198     Variance of error:             3.290
Count R2:                      0.753     Adj Count R2:                  0.460
AIC:                           1.112     AIC*n:                       274.596
BIC:                       -1058.148     BIC':                        -43.466
```

. linktest

```
Iteration 0:   log likelihood = -170.31356
Iteration 1:   log likelihood = -129.33092
Iteration 2:   log likelihood = -129.00561
Iteration 3:   log likelihood = -129.00319
Iteration 4:   log likelihood = -129.00319

Logistic regression                               Number of obs   =        247
                                                  LR chi2(2)      =      82.62
                                                  Prob > chi2     =     0.0000
Log likelihood = -129.00319                       Pseudo R2       =     0.2426
------------------------------------------------------------------------------
  camel_ownp |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        _hat |   .9787502   .1351935     7.24   0.000     .7137757    1.243725
      _hatsq |    .085501   .1104854     0.77   0.439    -.1310464    .3020484
       _cons |  -.1269629   .2278549    -0.56   0.577    -.5735503    .3196245
------------------------------------------------------------------------------
```

Annex VII

Average Treatment Effect for the Treated Result of Income of Households

```
. attnd incomehh camel_ownp , pscore(cpscore) comsup

 The program is searching the nearest neighbor of each treated unit.
 This operation may take a while.

ATT estimation with Nearest Neighbor Matching method
(random draw version)
Analytical standard errors
-------------------------------------------------------
n. treat.   n. contr.         ATT    Std. Err.          t
-------------------------------------------------------
      113          62   12677.813     5602.924      2.263
-------------------------------------------------------
Note: the numbers of treated and controls refer to actual
nearest neighbour matches

. atts incomehh camel_ownp , pscore(cpscore) blockid(cblock) comsup

ATT estimation with the Stratification method
Analytical standard errors
-------------------------------------------------------
n. treat.   n. contr.         ATT   Std. Err.           t
-------------------------------------------------------
      113         131   11312.367    6214.084       1.820
-------------------------------------------------------

. attr incomehh camel_ownp , pscore(cpscore) bootstrap reps(50) comsup

 The program is searching for matches of treated units within radius.
 This operation may take a while.

ATT estimation with the Radius Matching method
Analytical standard errors
-------------------------------------------------------
n. treat.   n. contr.         ATT   Std. Err.           t
-------------------------------------------------------
      113         131   10393.183    5048.434       2.059
-------------------------------------------------------
Note: the numbers of treated and controls refer to actual
matches within radius

Bootstrapping of standard errors

command:      attr incomehh camel_ownp , pscore(cpscore) comsup radius(.1)
statistic:    attr       = r(attr)

Bootstrap statistics                              Number of obs    =       250
                                                  Replications     =        50
------------------------------------------------------------------------------
Variable     |  Reps  Observed      Bias  Std. Err. [95% Conf. Interval]
-------------+----------------------------------------------------------------
        attr |    50  10393.18  214.2417  5566.257  -792.6285      21579   (N)
             |                                        1000.531    20588.7   (P)
             |                                        1000.531    20588.7  (BC)
------------------------------------------------------------------------------
```

```
Note:  N   = normal
       P   = percentile
       BC  = bias-corrected

ATT estimation with the Radius Matching method
Bootstrapped standard errors
-------------------------------------------------------
n. treat.   n. contr.         ATT   Std. Err.           t
-------------------------------------------------------
      113         131   10393.184    5566.257       1.867
-------------------------------------------------------
Note: the numbers of treated and controls refer to actual
matches within radius
```

. attk incomehh camel_ownp , pscore(cpscore) comsup bootstrap reps(50)

```
 The program is searching for matches of each treated unit.
 This operation may take a while.

ATT estimation with the Kernel Matching method
-------------------------------------------------------
n. treat.   n. contr.         ATT   Std. Err.           t
-------------------------------------------------------
      113         131   11440.651           .           .
-------------------------------------------------------
Note: Analytical standard errors cannot be computed. Use
the bootstrap option to get bootstrapped standard errors.

Bootstrapping of standard errors

command:      attk incomehh camel_ownp , pscore(cpscore) comsup bwidth(.06)
statistic:    attk       = r(attk)

Bootstrap statistics                              Number of obs    =       250
                                                  Replications     =        50
------------------------------------------------------------------------------
Variable     |  Reps  Observed      Bias  Std. Err. [95% Conf. Interval]
-------------+----------------------------------------------------------------
        attk |    50  11440.65 -382.0432  5997.977  -612.7354   23494.04   (N)
             |                                      -225.5409   25572.84   (P)
             |                                        1513.56   25971.42  (BC)
------------------------------------------------------------------------------
Note:  N   = normal
       P   = percentile
       BC  = bias-corrected

ATT estimation with the Kernel Matching method
Bootstrapped standard errors
-------------------------------------------------------
n. treat.   n. contr.         ATT   Std. Err.           t
-------------------------------------------------------
      113         131   11440.650    5997.977       1.907
-------------------------------------------------------
```

Annex VIII

Average Treatment Effect for the Treated Result of Livestock Ownership (TLU) of Households

```
. attnd  tlu camel_ownp , pscore(cpscore) comsup

 The program is searching the nearest neighbor of each treated unit.
 This operation may take a while.

ATT estimation with Nearest Neighbor Matching method
(random draw version)
Analytical standard errors
-------------------------------------------------------
n. treat.   n. contr.         ATT    Std. Err.          t
-------------------------------------------------------
      113          62       6.532        0.629     10.392
-------------------------------------------------------
Note: the numbers of treated and controls refer to actual
nearest neighbour matches
```

```
. atts  tlu camel_ownp , pscore(cpscore) blockid(cblock) comsup

ATT estimation with the Stratification method
Analytical standard errors
-------------------------------------------------------
n. treat.   n. contr.         ATT   Std. Err.           t
-------------------------------------------------------
      113         131       6.693       0.599      11.174
-------------------------------------------------------
```

```
. attr  tlu camel_ownp , pscore(cpscore) bootstrap reps(50) comsup

 The program is searching for matches of treated units within radius.
 This operation may take a while.

ATT estimation with the Radius Matching method
Analytical standard errors
-------------------------------------------------------
n. treat.   n. contr.         ATT   Std. Err.           t
-------------------------------------------------------
      113         131       6.788       0.518      13.113
-------------------------------------------------------
Note: the numbers of treated and controls refer to actual
matches within radius

Bootstrapping of standard errors
command:      attr tlu camel_ownp , pscore(cpscore) comsup radius(.1)
statistic:    attr       = r(attr)

Bootstrap statistics                              Number of obs    =       250
                                                  Replications     =        50
------------------------------------------------------------------------------
Variable     |  Reps  Observed      Bias  Std. Err. [95% Conf. Interval]
-------------+----------------------------------------------------------------
        attr |    50  6.787611 -.0159716  .5840384   5.613942   7.961281   (N)
             |                                        5.563318   7.853647   (P)
             |                                        5.563318   7.853647  (BC)
------------------------------------------------------------------------------
```

```
Note:  N   = normal
       P   = percentile
       BC  = bias-corrected

ATT estimation with the Radius Matching method
Bootstrapped standard errors
---------------------------------------------------------
n. treat.   n. contr.         ATT   Std. Err.           t
---------------------------------------------------------
      113         131       6.788       0.584      11.622
---------------------------------------------------------
Note: the numbers of treated and controls refer to actual
matches within radius
```

. attk tlu camel_ownp , pscore(cpscore) comsup bootstrap reps(50)

```
 The program is searching for matches of each treated unit.
 This operation may take a while.

ATT estimation with the Kernel Matching method

---------------------------------------------------------
n. treat.   n. contr.         ATT   Std. Err.           t
---------------------------------------------------------
      113         131       6.619           .           .
---------------------------------------------------------
Note: Analytical standard errors cannot be computed. Use
the bootstrap option to get bootstrapped standard errors.

Bootstrapping of standard errors

command:      attk tlu camel_ownp , pscore(cpscore) comsup bwidth(.06)
statistic:    attk       = r(attk)

Bootstrap statistics                              Number of obs    =       250
                                                  Replications     =        50
------------------------------------------------------------------------------
Variable     |  Reps  Observed      Bias  Std. Err. [95% Conf. Interval]
-------------+----------------------------------------------------------------
        attk |    50  6.618618   .003231  .6394149   5.333666    7.90357   (N)
             |                                        5.453091   7.918579   (P)
             |                                        5.375245   7.552855  (BC)
------------------------------------------------------------------------------
Note:  N   = normal
       P   = percentile
       BC  = bias-corrected

ATT estimation with the Kernel Matching method
Bootstrapped standard errors

---------------------------------------------------------
n. treat.   n. contr.         ATT   Std. Err.           t
---------------------------------------------------------
      113         131       6.619       0.639      10.351
---------------------------------------------------------
```

Annex IX

Average Treatment Effect for the Treated Result of Fixed Asset Value of Households

```
. attnd lnass_value camel_ownp , pscore(cpscore) comsup

 The program is searching the nearest neighbor of each treated unit.
 This operation may take a while.

ATT estimation with Nearest Neighbor Matching method
(random draw version)
Analytical standard errors
-------------------------------------------------------
n. treat.   n. contr.         ATT    Std. Err.          t
-------------------------------------------------------
      113          62       0.019        0.268      0.072
-------------------------------------------------------
Note: the numbers of treated and controls refer to actual
nearest neighbour matches
```

```
. atts lnass_value camel_ownp , pscore(cpscore) blockid(cblock) comsup

ATT estimation with the Stratification method
Analytical standard errors
-------------------------------------------------------
n. treat.   n. contr.         ATT   Std. Err.           t
-------------------------------------------------------
      113         131       0.006       0.187       0.033
-------------------------------------------------------
```

```
. attr lnass_value camel_ownp , pscore(cpscore) bootstrap reps(50) comsup

 The program is searching for matches of treated units within radius.
 This operation may take a while.

ATT estimation with the Radius Matching method
Analytical standard errors
-------------------------------------------------------
n. treat.   n. contr.         ATT   Std. Err.           t
-------------------------------------------------------
       89         130       0.058       0.140       0.413
-------------------------------------------------------
Note: the numbers of treated and controls refer to actual
matches within radius
```

```
. attk lnass_value camel_ownp , pscore(cpscore) comsup bootstrap reps(50)

 The program is searching for matches of each treated unit.
 This operation may take a while.

ATT estimation with the Kernel Matching method
-------------------------------------------------------
n. treat.   n. contr.         ATT   Std. Err.           t
-------------------------------------------------------
      113         131       0.030           .           .
-------------------------------------------------------
Note: Analytical standard errors cannot be computed. Use
the bootstrap option to get bootstrapped standard errors.
```

```
Bootstrapping of standard errors

command:      attk lnass_value camel_ownp , pscore(cpscore) comsup bwidth(.06)
statistic:    attk       = r(attk)

Bootstrap statistics                              Number of obs    =       250
                                                  Replications     =        50
------------------------------------------------------------------------------
Variable     |  Reps  Observed      Bias  Std. Err. [95% Conf. Interval]
-------------+----------------------------------------------------------------
        attk |    50  .0296932 -.0447802  .1633695  -.2986101   .3579964   (N)
             |                                      -.3911946   .2837295   (P)
             |                                      -.3911946   .3843621  (BC)
------------------------------------------------------------------------------
Note:  N   = normal
       P   = percentile
       BC  = bias-corrected

ATT estimation with the Kernel Matching method
Bootstrapped standard errors
-------------------------------------------------------
n. treat.   n. contr.         ATT   Std. Err.           t
-------------------------------------------------------
      113         131       0.030       0.163       0.182
-------------------------------------------------------
```

Annex X

Simulation-Based Sensitivity Analysis Results

```
. sensatt incomehh camel_ownp sexhh agehh educhh acc_credit famexp_co
adulthh adul_ratio , p11(0.95) p10(0.90) p01(0.85) p00(0.65) r(50) ycent(
> 50) comsup logit

*** THIS IS THE BASELINE ATT ESTIMATION (WITH NO SIMULATED CONFOUNDER).

 The program is searching the nearest neighbor of each treated unit.
 This operation may take a while.

ATT estimation with Nearest Neighbor Matching method
(random draw version)
Analytical standard errors
-------------------------------------------------------
n. treat.   n. contr.         ATT    Std. Err.          t
-------------------------------------------------------
      113          62   12677.813     5602.924      2.263
-------------------------------------------------------
Note: the numbers of treated and controls refer to actual
nearest neighbour matches


*** THIS IS THE SIMULATED ATT ESTIMATION (WITH THE CONFOUNDER U).

The probability of having U=1 if T=1 and Y=1 (p11) is equal to:     0.95
The probability of having U=1 if T=1 and Y=0 (p10) is equal to:     0.90
The probability of having U=1 if T=0 and Y=1 (p01) is equal to:     0.85
The probability of having U=1 if T=0 and Y=0 (p00) is equal to:     0.65

The probability of having U=1 if T=1 (p1.) is equal to:     0.93
The probability of having U=1 if T=0 (p0.) is equal to:     0.73


 The program is iterating the ATT estimation with simulated confounder.
 You have chosen to perform 50 iterations. This step may take a while.

ATT estimation with simulated confounder
General multiple-imputation standard errors
-----------------------------------------------
      ATT    Std. Err.    Out. Eff.   Sel. Eff.
-----------------------------------------------
12554.901    8261.672        4.184       5.358
-----------------------------------------------
Note: Both the outcome and the selection effect
are odds ratios from logit estimations.

. sensatt incomehh camel_ownp sexhh agehh educhh acc_credit famexp_co
adulthh adul_ratio , p11(0.95) p10(0.80) p01(0.75) p00(0.65) alg(attk) r(
> 50) ycent(50) comsup logit

*** THIS IS THE BASELINE ATT ESTIMATION (WITH NO SIMULATED CONFOUNDER).

 The program is searching for matches of each treated unit.
 This operation may take a while.
```

```
ATT estimation with the Kernel Matching method
-------------------------------------------------------
n. treat.   n. contr.         ATT   Std. Err.           t
-------------------------------------------------------
      113         131   11440.651           .           .
-------------------------------------------------------
Note: Analytical standard errors cannot be computed. Use
the bootstrap option to get bootstrapped standard errors.


*** THIS IS THE SIMULATED ATT ESTIMATION (WITH THE CONFOUNDER U).

The probability of having U=1 if T=1 and Y=1 (p11) is equal to:     0.95
The probability of having U=1 if T=1 and Y=0 (p10) is equal to:     0.80
The probability of having U=1 if T=0 and Y=1 (p01) is equal to:     0.75
The probability of having U=1 if T=0 and Y=0 (p00) is equal to:     0.65

The probability of having U=1 if T=1 (p1.) is equal to:     0.89
The probability of having U=1 if T=0 (p0.) is equal to:     0.69


 The program is iterating the ATT estimation with simulated confounder.
 You have chosen to perform 50 iterations. This step may take a while.


ATT estimation with simulated confounder
General multiple-imputation standard errors
-----------------------------------------------
      ATT    Std. Err.    Out. Eff.   Sel. Eff.
-----------------------------------------------
10452.810           .        1.956       3.503
-----------------------------------------------
Note: Both the outcome and the selection effect
are odds ratios from logit estimations.
```

. sensatt incomehh camel_ownp sexhh agehh educhh acc_credit famexp_co adulthh adul_ratio , p11(0.90) p10(0.90) p01(0.60) p00(0.55) alg(attr) r(> 50)ycent(50)comsup logit

```
*** THIS IS THE BASELINE ATT ESTIMATION (WITH NO SIMULATED CONFOUNDER).

 The program is searching for matches of treated units within radius.
 This operation may take a while.

ATT estimation with the Radius Matching method
Analytical standard errors
-------------------------------------------------------
n. treat.   n. contr.         ATT   Std. Err.           t
-------------------------------------------------------
      113         131   10386.735    5048.430       2.057
-------------------------------------------------------
Note: the numbers of treated and controls refer to actual
matches within radius
```

```
*** THIS IS THE SIMULATED ATT ESTIMATION (WITH THE CONFOUNDER U).

The probability of having U=1 if T=1 and Y=1 (p11) is equal to:     0.90
The probability of having U=1 if T=1 and Y=0 (p10) is equal to:     0.90
The probability of having U=1 if T=0 and Y=1 (p01) is equal to:     0.60
The probability of having U=1 if T=0 and Y=0 (p00) is equal to:     0.55

The probability of having U=1 if T=1 (p1.) is equal to:     0.90
The probability of having U=1 if T=0 (p0.) is equal to:     0.57


 The program is iterating the ATT estimation with simulated confounder.
 You have chosen to perform 50 iterations. This step may take a while.

ATT estimation with simulated confounder
General multiple-imputation standard errors
-----------------------------------------------
      ATT    Std. Err.    Out. Eff.   Sel. Eff.
-----------------------------------------------
10254.971    5552.525        1.394       7.699
-----------------------------------------------
Note: Both the outcome and the selection effect
are odds ratios from logit estimations.
```

. sensatt tlu camel_ownp sexhh agehh educhh acc_credit famexp_co adulthh adul_ratio , p11(0.85) p10(0.85) p01(0.75) p00(0.50) r(50) ycent(50)c
> omsup logit

```
*** THIS IS THE BASELINE ATT ESTIMATION (WITH NO SIMULATED CONFOUNDER).

 The program is searching the nearest neighbor of each treated unit.
 This operation may take a while.

ATT estimation with Nearest Neighbor Matching method
(random draw version)
Analytical standard errors
-------------------------------------------------------
n. treat.   n. contr.         ATT    Std. Err.          t
-------------------------------------------------------
      113          62       6.532        0.629     10.392
-------------------------------------------------------
Note: the numbers of treated and controls refer to actual
nearest neighbour matches


*** THIS IS THE SIMULATED ATT ESTIMATION (WITH THE CONFOUNDER U).

The probability of having U=1 if T=1 and Y=1 (p11) is equal to:     0.85
The probability of having U=1 if T=1 and Y=0 (p10) is equal to:     0.85
The probability of having U=1 if T=0 and Y=1 (p01) is equal to:     0.75
The probability of having U=1 if T=0 and Y=0 (p00) is equal to:     0.50

The probability of having U=1 if T=1 (p1.) is equal to:     0.85
The probability of having U=1 if T=0 (p0.) is equal to:     0.53

 The program is iterating the ATT estimation with simulated confounder.
 You have chosen to perform 50 iterations. This step may take a while.
```

```
ATT estimation with simulated confounder
General multiple-imputation standard errors
-----------------------------------------------
      ATT    Std. Err.    Out. Eff.   Sel. Eff.
-----------------------------------------------
    6.518       0.768        4.000       5.859
-----------------------------------------------
Note: Both the outcome and the selection effect
are odds ratios from logit estimations.
```

. sensatt tlu camel_ownp sexhh agehh educhh acc_credit famexp_co adulthh adul_ratio , p11(0.95) p10(0.95) p01(0.80) p00(0.30) alg(attk) r(50) y > cent(50) comsup logit

```
*** THIS IS THE BASELINE ATT ESTIMATION (WITH NO SIMULATED CONFOUNDER).

 The program is searching for matches of each treated unit.
 This operation may take a while.

ATT estimation with the Kernel Matching method

-------------------------------------------------------
n. treat.   n. contr.         ATT   Std. Err.           t
-------------------------------------------------------
      113         131       6.619           .           .
-------------------------------------------------------
Note: Analytical standard errors cannot be computed. Use
the bootstrap option to get bootstrapped standard errors.


*** THIS IS THE SIMULATED ATT ESTIMATION (WITH THE CONFOUNDER U).

The probability of having U=1 if T=1 and Y=1 (p11) is equal to:     0.95
The probability of having U=1 if T=1 and Y=0 (p10) is equal to:     0.95
The probability of having U=1 if T=0 and Y=1 (p01) is equal to:     0.80
The probability of having U=1 if T=0 and Y=0 (p00) is equal to:     0.30

The probability of having U=1 if T=1 (p1.) is equal to:     0.95
The probability of having U=1 if T=0 (p0.) is equal to:     0.36

 The program is iterating the ATT estimation with simulated confounder.
 You have chosen to perform 50 iterations. This step may take a while.

ATT estimation with simulated confounder
General multiple-imputation standard errors
-----------------------------------------------
      ATT    Std. Err.    Out. Eff.   Sel. Eff.
-----------------------------------------------
    5.895           .       17.439      60.638
-----------------------------------------------
Note: Both the outcome and the selection effect
are odds ratios from logit estimations.
```

. sensatt tlu camel_ownp sexhh agehh educhh acc_credit famexp_co adulthh adul_ratio , p11(0.90) p10(0.90) p01(0.75) p00(0.35) alg(attr) r(50) y > cent(50) comsup logit

```
*** THIS IS THE BASELINE ATT ESTIMATION (WITH NO SIMULATED CONFOUNDER).

 The program is searching for matches of treated units within radius.
 This operation may take a while.
ATT estimation with the Radius Matching method
Analytical standard errors
-------------------------------------------------------
n. treat.   n. contr.         ATT   Std. Err.           t
-------------------------------------------------------
      113         131       6.788       0.518      13.113
-------------------------------------------------------
Note: the numbers of treated and controls refer to actual
matches within radius


*** THIS IS THE SIMULATED ATT ESTIMATION (WITH THE CONFOUNDER U).

The probability of having U=1 if T=1 and Y=1 (p11) is equal to:     0.90
The probability of having U=1 if T=1 and Y=0 (p10) is equal to:     0.90
The probability of having U=1 if T=0 and Y=1 (p01) is equal to:     0.75
The probability of having U=1 if T=0 and Y=0 (p00) is equal to:     0.35

The probability of having U=1 if T=1 (p1.) is equal to:     0.90
The probability of having U=1 if T=0 (p0.) is equal to:     0.40


 The program is iterating the ATT estimation with simulated confounder.
 You have chosen to perform 50 iterations. This step may take a while.

ATT estimation with simulated confounder
General multiple-imputation standard errors
-----------------------------------------------
      ATT    Std. Err.    Out. Eff.   Sel. Eff.
-----------------------------------------------
    6.475       0.560       10.584      17.017
-----------------------------------------------
Note: Both the outcome and the selection effect
are odds ratios from logit estimations.
```

Annex XI

Ordered Probit Estimation Results for Households' Camel Rent Decision

```
. tab cmlrent_dec

 Households'|
  Camel Rent|
   Decision |       Freq.     Percent        Cum.
------------+-----------------------------------
          1 |         67       58.26       58.26
          2 |         19       16.52       74.78
          3 |         29       25.22      100.00
------------+-----------------------------------
      Total |        115      100.00

. oprobit cmlrent_dec agehh educhh adumale acc_credit incomehh camels_hh, robust

Iteration 0:   log pseudolikelihood = -110.35687
Iteration 1:   log pseudolikelihood = -95.642061
Iteration 2:   log pseudolikelihood = -95.539322
Iteration 3:   log pseudolikelihood = -95.539236
Iteration 4:   log pseudolikelihood = -95.539236

Ordered probit regression                       Number of obs   =        115
                                                Wald chi2(6)    =      32.01
                                                Prob > chi2     =     0.0000
Log pseudolikelihood = -95.539236               Pseudo R2       =     0.1343

------------------------------------------------------------------------------
             |               Robust
  cmlrent_dec|      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       agehh |  -.0151016   .0173676    -0.87   0.385    -.0491414    .0189382
      educhh |   .5232702   .2939674     1.78   0.075    -.0528953    1.099436
     adumale |  -.2102252   .1454212    -1.45   0.148    -.4952456    .0747952
  acc_credit |  -.2206031    .312295    -0.71   0.480      -.83269    .3914838
    incomehh |  -9.67e-07   2.16e-06    -0.45   0.654    -5.20e-06    3.26e-06
   camels_hh |  -.1105837   .0358947    -3.08   0.002     -.180936   -.0402314
-------------+----------------------------------------------------------------
       /cut1 |  -2.675914    .686691                     -4.021803   -1.330024
       /cut2 |  -.7296074   .6320087                     -1.968322    .5091068
------------------------------------------------------------------------------
```

```
. mfx compute, predict(outcome(3))
```

Marginal effects after oprobit

```
      y  = Pr(cmlrent_dec ==3) (predict, outcome(3))
         =  .21185885

------------------------------------------------------------------------------
variable |      dy/dx    Std. Err.     z    P>|z|  [    95% C.I.   ]      X
---------+--------------------------------------------------------------------
   agehh |  -.0043748      .00505   -0.87   0.386  -.014268  .005518   37.4957
  educhh*|   .1700737      .10436    1.63   0.098   .034465  .374612   .173913
 adumale |   -.060901      .04228   -1.44   0.150  -.143765  .021963   1.63478
acc_cr~t*|  -.0604487      .07985   -0.76   0.449   -.21695  .096053        .2
incomehh |  -2.80e-07      .00000   -0.45   0.656  -1.5e-06  9.5e-07   35984.9
camels~h |  -.0320355      .01074   -2.98   0.003  -.053077 -.010994   5.71304
------------------------------------------------------------------------------
(*) dy/dx is for discrete change of dummy variable from 0 to 1
```

. linktest

```
Iteration 0:   log likelihood = -110.35687
Iteration 1:   log likelihood = -94.474942
Iteration 2:   log likelihood = -94.351109
Iteration 3:   log likelihood = -94.350977
Iteration 4:   log likelihood = -94.350977

Ordered probit regression                       Number of obs   =        115
                                                LR chi2(2)      =      32.01
                                                Prob > chi2     =     0.0000
Log likelihood = -94.350977                     Pseudo R2       =     0.1450
------------------------------------------------------------------------------
 cmlrent_dec |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        _hat |   2.083146   .7271345     2.86   0.004     .6579886    3.508303
      _hatsq |   .3015771   .1917053     1.57   0.116    -.0741584    .6773127
-------------+----------------------------------------------------------------
       /cut1 |  -3.528193   .6741262                     -4.849456    -2.20693
       /cut2 |  -1.555115   .6169528                      -2.76432   -.3459099
------------------------------------------------------------------------------
```

Annex XII

Questionnaire Used for Survey

Assessing "The Impact of Camel Transportation on the Livelihood of Pastoralists: In Berahle Woreda, Afar Regional State of Ethiopia"

Date of interview	Time Started	Time Finished	Interviewer's Name	Supervisor's Name

Household ID Code	Woreda	Kebelle	Kushet	Got

Household's home distance from Main Market (Kilometer)	Household's home distance from Local Market (Kilometer)	Household's home distance from asphalt road (Kilometer)	Household's home distance from gravel road (Kilometer)

Code A: Relation to the Household Head

1 Household head
2 Husband /Wife
3 Natural Son/ Daughter
4 Step Son/Daughter
5 Grandchild
6 Father/Mother
7 Father (In-Law)/Mother (In-Law)
8 Sister (In-Law)/Brother (In-Law)
9 Son (In-Law)/Daughter (In-Law)
10 Step Father/Step Mother
11 Niece/Nephew
12 Uncle/Aunt
13 Brother/ Sister
14 Servant
15 Other relatives
16 Other unrelated person

Code B: Marital Status

1 Single
2 Married
3 Divorced
4 Separated
5 Widowed

Code C: Educational Level

0 Too young to attend school (Child)
1 Formal school never attended (Illiterate)
2 Primary school (1 - 6)
3 Junior school (7 - 8)
4 Secondary school (9 - 12)
5 Post secondary school (Diploma, Degree and above)
6 Never attended but can read and write

Code D: Religion

1 Orthodox
2 Muslim
3 Catholic
4 Protestant
5 Other _____
(Please Specify)

Code E: Labor Capacity:

1 Child (too young to work)
2 Working child around home
3 'Adult assistant' (young boys & girls)
4 Adult (able to do full adult work load)
5 Elderly
6 Permanently disabled
7 Chronically ill (unable to work temporarily)

Code F: Main Activity

1 Crop farming
2 Livestock production
3 Trade
4 Soldier/ Police
5 Handicraft
6 Professional
7 Laborer (skilled)
8 Laborer (unskilled)
9 Student
10 Domestic worker (including housewife)
11 Teacher (religious)
12 Other, Specify_____

Code G: Work Status

1 Full time
2 Part time

Section A. Household Characteristics

A.1 Name of the Household Member (Those who are alive only)	A.2 ID	A.3 Relation to the Household Head Code(A)	A.4 Sex 1= Male 0= Female	A.5 Age (Year)	A.6 Marital Status Code (B)	A.7 Educational Level Code (C)	A.8 Religion Code (D)	A.9 Labor Capacity Code (E)	A.10 Are you a pastoralist or agro-pastoralist? 1= Pastoralist 2= Agro-pastoralist 3= Other	A.11 Occupation of the household member Code (F)	A.12 Work status Code (G)
(Household Head)	01										
	02										
	03										
	04										
	05										
	06										
	07										
	08										
	09										
	10										
	11										
	12										
	13										
	14										
	15										

Section B. Household Asset ownership and Value

Section B1. Household Livestock ownership and Value

B1.1 Name of the livestock	B1.2 Number owned at present	B1.3 Total present market value (Birr)	B1.4 During the last year, how many were born?	B1.5 During the last year, how many were lost/ died?	B1.6 Number owned but away	B1.7 Number not owned but cared for?	B1.8 Did you buy any ... during last year (2005 E.C or 2012/03)			B1.9 Did you sell any ... during last year (2005 E.C or 2012/03)		
							B1.8a Number bought ***(if none, write 0)***	B1.8b Total Purchase value of all bought	B1.8c Financing means of the Purchase	B1.9a Number sold ***(if none, write 0)***	B1.9b Total sales value of all sold	B1.9c Reason for sell
Camel												
Cow												
Heifer												
Bull												
Ox												
Calve (under 1 year)												
Goat												
Pig												
Sheep												
Donkey												
Horse												
Mule												
Chicken												
Bee hives												

Section B2. Household ownership of other assets and Value

B2.1 Asset Description	B2.2 Number owned at present	B2.3 Total present market value (Birr)
House		
Trees		
Radio		
Tape Recorder		
Television		
Land Phone		
Mobile Phone		
Ventilator		
Buffee		
Bed		
Sofa		
Bajaj		
Bicycle		
Motor Bicycle		
Car		
Cart		
Flour Mill		
Refrigerator		

Section C. Household Non-farm Activities and Income

Section C1. Employment for Wage

Did any member of the household employed for wage in the last year?

1= Yes (give the following details)

0= No (go to the next section)

C1.1 ID code of household member	C1.2 Kind of work (Code a below)	C1.3 Location of employment (Code b below)	C1.4 Is the work 1= Permanent 0= Temporary	C1.5 For how many months out of the last 12 months did you work?	C1.6 How many days per month did you work on average?	C1.7 Total amount earned per month (+ taxes) (Birr)

Code a (type of employment)	**Code b (location of employment)**	**Code c (where did s/he migrate)**
1. Farm worker for pay 2. Traditional labor sharing 3. Trader 4. Professional 5. Laborer (skilled) 6. Soldier 7. Unskilled worker 8. Domestic servant 9. Driver/ mechanic 10. Other, specify _____	1. This kushet 2. Other kushet in the same kebelle 3. Other kebelle in the same woreda 4. Neighbor woreda 5. Another zone 6. Another state 7. Mekelle 8. Addis Ababa **9.** Foreign country **10.** Other, specify _____	1. Other woreda within the region 2. Other region in Ethiopia 3. Mekelle 4. Addis Ababa **5.** Foreign countries

Section C2. Own Business Activities

Did any member of the household carried out some own business activities in the last year?

1= Yes (give the following details)
0= No (go to next section)

C2.1 Activities	C2.2 ID code of responsible household members	C2.3 For how many months out of the last 12 months have you worked?	C2.4 How many days per month did you work on average?	C2.5 Total amount earned per month (Birr) - If it is received in kind, change it to cash (Birr).	C2.6 Were you hiring labor to do these activities? 1= Yes 0= No	C2.7 If yes,	
						C2.7a Total days worked	C2.7b Total amount of wage paid (Birr)
Trade in livestock							
Traditional healer/ Religious teacher							
Selling salt							
Trade in grain or any kind of good							
Hair dressing							
Handicraft							
Milling							
Weaving							
Selling wood and charcoal							
Transporting goods by pack animal							
Selling chat and soft drinks							
Other, specify							

Section C3. Migration and Income

Has any member of the household left the household's residence seeking a job last year?

1= Yes (give the following details)
0= No (go to next section)

C3.1 ID code of the household member	C3.2 Where did s/he go? (code c above)	C3.3 Date of departure Day/month/year	C3.4 Date of return if s/he has returned Day/month/year	C3.5 Did s/he get work there 1= Yes 0= No	C3.6 Type of work (code a above)	C3.7 How many days per month did s/he work on average?	C3.8 Total amount earned per month (Birr)	C3.9 How much s/he send back? (Birr)	C3.10 How much did s/he bring back when s/he return (if returned)? (Birr)

Section C4. Transfers (Remittance and Aid)

Has the household received any other income (such as remittance, aid or gift) last year?

1= Yes (give the following details) 0= No (go to the next section)

C4.1 Type of receipt 1. Remittance 2. Food aid 3. Gift 4. Inheritance 5. Dowry 6. Other, specify	C4.2 At what interval do you receive this transfer? 1. Per month 2. Per three months 3. Per six months 4. Per year 5. Other, specify	C4.3 Total amount received in the last 12 months (year 2005 E.C. or 2012/13) - If it is received in kind, change it to cash (Birr).	C4.4 Is the person who send the transfer 1. Non residence household member 2. Relatives of household member 3. Friends 4. Government 5. NGOs 6. Other, specify

Section C5. Sale of Livestock By-products

Has the household sold any by-product of its livestock last year?

1= Yes (give the following details)
0= No (go to the next section)

C5.1 Type of livestock by-product sold	C5.2 Total amount sold in the last 12 months	C5.3 Total amount received (sales value) - If it is received in kind, change it to cash (Birr)
Milk (liter)		
Butter (kg)		
Meat (kg)		
Egg (number)		
Honey (kg)		
Hides and skins (number)		
Other, specify		

1. As a household head, how much was the percentage of your monthly income out of the total monthly income of the household last year?
   _____ %
2. In what way has the economic condition and income of your household changed over time?
   1. Improved
   2. Stayed the same
   3. Worsened
   4. I don't know
3. Do you have an access to electricity?

   1= Yes 0= No

4. Do you have an access to drinking water?

   1= Yes 0= No

5. Do you have an access to credit?

   1= Yes 0= No

6. If yes, can you tell us for what purpose most of the time you borrow?
   1. _____
   2. _____
   3. _____
7. Are you member of local institutions?

   1= Yes 0= No

8. What are the names of the local institutions in which you mostly participate?
   1. _____
   2. _____
   3. _____
9. Do you participate in extension services?

   1= Yes 0= No

Section D. Camel Rent and Salt Transportation Experiences of Camel Owner Pastoral Households

1. How much is the average distance from your current residence to the place where salt is extracted on foot?
   Single trip: _____ days/ _____ hours/ _____ kms
   Double trip: _____ days/ _____ hours/ _____ kms
2. On average, how many hours per day do you walk (if for days) when you go from home to the salt mining area?
   _____ Hours
3. How much is the average distance from the salt mining area to the market place where it is sold on foot?
   Single trip: _____ days/ _____ hours/ _____ kms
   Double trip: _____ days/ _____ hours/ _____ kms
4. On average, how many hours per day do you walk (if for days) when you go from the salt mining area to the market?
   _____ Hours
5. In which woreda market do you most of the time sale your salt?
   1. Berhale
   2. Koneba
   3. Other, please specify _____

6. Have you ever been rented out your camels for other salt transporters? If “No”, proceed to question # 14

   1= Yes 0= No

7. If the answer to question # 6 is yes, what are the factors that motivate you to rent out your camels? Multiple answers are possible.

   (Open question: do not read the options, just select according to the answers obtained)

   1. The benefit that I can get from camel rent is better than that of I can be benefited by transporting salt my self
   2. I can’t transport salt and go far by myself because of my age
   3. I don’t want to transport salt/ I hate transporting salt
   4. The journey is too long that makes me too tired because of my disability
   5. Since I am a female, I can’t transport salt and go far by myself
   6. I have a health problem. I can’t go far and transport salt by myself because of my sickness.
   7. I have another job and I don’t have time for salt transportation
   8. The income that I get from other sources is not satisfactory and sufficient enough to satisfy my family’s demand
   9. I am married and have children that I have to take care of and I can’t depart from my family then I rent out my camels
   10. There is no adult member in the household that could be capable of transporting salt
   11. The number of camels that I hold is not much enough for me to transport salt my self
   12. Other, specify_____

8. On average, how many times per year do you rent out your camels for other salt transporters?

   _____ Months per year/ _____ Days per month

9. How many camels do you rent out at a time (on average)?

   _____ Camels

10. How much rent do you receive?

    _____Birr per camel/ _____ salt blocks per camel/ _____ camels’ carriage of salt out of the total camels rented

11. Do you pay tax for the income that you receive from camel rent?

    1= Yes

    0= No

12. If the answer to question # 11 is yes,

    How much/what percentage do you pay from the income that you get by renting out camels?

    _____Birr per camel/ _____Birr per salt block/ _____ blocks of salt per camel/ _____ **%** of the total income

13. For how many years have you been renting out camels?

    _____ Years

14. If the answer to question # 6 is “No”, what are the reasons which make you not to rent out your camels? Multiple answers are possible.

    (Open question: do not read the options, just select according to the answers obtained)

1. I want to use my camels by myself because I don't believe that anybody can take care of them like that of me
2. The income that I can get by transporting salt my self is better than the income that I can get from camel rent
3. I don't have another job and salt transportation is my main activity that I have to undertake it by myself
4. The income that I gain from camel rent is not that much satisfactory
5. I am single and have no children that makes me not to go far
6. There are adult male members in the household, no need of renting out camels, since we can transport salt by ourselves
7. Other, specify_____

15. Have you ever been transported salt by yourself?

    1= Yes

    0= No

16. If the answer to question # 15 is yes,

    How often do you transport salt?

    _____times per month/ _____times per year

17. How many camels on average do you take at a time to the salt extraction area when you purposely go to transport salt?

    _____ Camels

18. How many days does it take you from the time that you get out of your home for the purpose of salt transportation until you come back again? (Including the time that you spent on salt loading, double trip transportation and salt selling).

    _____ Days

19. Which members of the household do most of the time transport salt? (rank in order of their participation)
    1. _____
    2. _____
    3. _____

20. Which of the following are the main salt transporting months throughout the year for you? (Rank in order of their convenience for salt transportation for you).

	Rank (1-12)
1. September	_____
2. October	_____
3. November	_____
4. December	_____
5. January	_____
6. February	_____
7. March	_____

8. April _____
9. May _____
10. June _____
11. July _____
12. August _____

21. Why are these months preferred? Multiple answers are possible.
    1. _____
    2. _____
    3. _____
22. Which members of the household do decide on whether to rent out camels or to transport salt by oneself or both?
    1. Husband
    2. Wife
    3. Children
    4. Husband and Wife
    5. All members of the household
    6. Others
23. Have you ever been used other alternative means of transporting salt other than camel?

    1= Yes 0= No

24. If the answer to question # 23 is yes,
    What are the means of transportation that you have ever used? (Rank in order of their frequency of usage)

	Rank (1-5)
1. Car	_____
2. Cartel/ horses	_____
3. Mules	_____
4. Donkey	_____
5. Other, specify _____	_____

25. For how many years have you been transporting salt?
    _____ Years
26. When was the last time that you transported salt?
    Month _____/ Year _____
27. Do you pay tax for the income that you receive by transporting salt?
    1= Yes 0= No

28. If the answer to question # 27 is yes,
    How much/what percentage do you pay from the income that you get by transporting salt?
    _____Birr per camel/ _____Birr per salt block/ _____ blocks of salt per camel/ _____ **%** of the total income
29. Were your parents (parents of the household head) camel owners?

    1= Yes 0= No

30. Are your neighbors camel owners at this time?
    1= Yes 0= No

Section E: Fodder and Water Supplies for Camels

31. How many times per day on average do your camels feed when they are at home?
    1. Once
    2. Twice
    3. Three times
    4. Other, Specify _____
32. How frequently do your camels feed on average when they are at journey?
    1. Once a day
    2. Twice a day
    3. Once a week
    4. Twice per week
    5. Other, Specify _____
33. From where did you get fodder for your camels while at home? More than one answer is possible.
    1. By collecting from other places and providing it to them at home
    2. By buying from market
    3. By letting the camels to feed in a free field
    4. Other, Specify _____
34. From where did you provide this fodder for your camels when at journey? More than one answer is possible.
    1. I let them to eat where ever it is found on our way
    2. I make them to carry an amount of fodder which is sufficient for them throughout the journey
    3. By buying from market
    4. Other, Specify _____
35. What are the main fodder types that your camels feed? Multiple answers are possible.

1. _____
2. _____
3. _____

36. How much fodder do you provide for your single camel at a time on average?
_____ Kg/ _____ local unit (Daka)

37. How frequently do on average your camels drink water when they are at home?
    1. Once a day
    2. Several times a week
    3. Twice a week
    4. Once a week
    5. Once in two weeks
    6. Once a month
    7. Other, Specify _____

38. How frequently do they on average drink water while at journey?
    1. Once a day
    2. Several times a week
    3. Twice a week
    4. Once a week
    5. Once in two weeks
    6. Once a month
    7. Other, Specify _____

39. How did you provide water for your camels when they are at home? More than one answer is possible.
    1. By taking them to the nearest rivers and natural water bodies
    2. By fetching from rivers and providing it to them to drink at home
    3. From pipe water which is available in our kebelle
    4. Other, Specify _____

40. From where do your camels drink water while they are at journey? More than one answer is possible.
    1. I let them to drink if and only if rivers and natural water bodies are available on our way
    2. I make them to carry an amount of water which is sufficient for them throughout the journey
    3. They don’t drink water while they are at journey
    4. They drink pipe water in towns which we get on our way
    5. Other, Specify _____

41. How much water does your single camel drink at a time on average?

_____ Liters/ _____ local unit (Jerikan)

Section F: General Questions about Your Camels and Your Pastoral Life

42. How much was the total monthly expenditure of the household on veterinary services, food and water for owned camels last year?

_____ Birr

43. Is the number of your camels
    1. Increasing over time
    2. Constant over time
    3. Decreasing over time
44. If the answer to question #43 is 1,

    How?

    _____

    _____ .

45. If the answer to question #43 is 3,

    What are the factors?
    1. Recurrent drought (shortage of feed and water)
    2. Disease that cause death
    3. Rustling
    4. Other, please specify_____
46. For how many years have you been in camel production?
    1. _____ Years
    2. My whole life
47. Are there camels that you have gotten as a gift among your present holdings?

    1= Yes 0= No
48. If the answer to question # 47 is yes, how many are they in number?

    _____ Camels
49. What is the type of placement of the houses in your Kushet?

    1= Clustered

    0= Scattered

50. What is your housing structure?
    1. Permanent
    2. Temporary (Nomadic)
    3. Other, Specify _____

51. Do you think that there are national laws, regulations and policies which have a negative effect on pastoralism?

    1= Yes
    0= No

52. If the answer to question #51 is yes,
    Which of the major areas of national laws, regulations and policies do you think affect pastoralism more? (Rank them in order of their influence). Multiple answers are possible.

    (Open question: do not read the options, just select according to the answers obtained)

	Rank
1. Federalism	_____
2. Taxation and livestock fees	_____
3. Trade and export of animals	_____
4. Land commission	_____
5. Local governance	_____
6. Agricultural laws	_____
7. Land law (right and tenure)	_____
8. Investment promotion	_____
9. Pastoral institutions	_____
10. Animal health laws	_____
11. Problems with natural resources management	_____
12. Others, specify _____	_____

53. What are the major challenges that you are facing as a resident in your community?
    1. Water scarcity
    2. Pasture scarcity and depletion
    3. Climate and climate changes
    4. Desertification and decline in natural resources
    5. Shortage of supply of basic services such as education, health, drinking water and electricity
    6. Mobility, livestock migration and routes, restriction of movement

7. Livestock health
8. Governance voice
9. Poor understanding of pastoralism
10. Others, please specify _____

54. Would you agree that camel transportation is highly relevant and basic for work and livelihoods of pastoralists?
    1. Strongly agree
    2. Agree
    3. No opinion
    4. Disagree
    5. Strongly disagree
55. Taking all things together, how do you set your level of satisfaction with your living standard?
    1. Very satisfied
    2. Somewhat satisfied
    3. Neutral
    4. Somewhat dissatisfied
    5. Very dissatisfied
56. What else would you like to tell us? What do you think if salt transportation using camels is replaced by other modern means of transportation? Will it have any consequence?

    _____
    _____
    _____
    _____ .

This is the end of the survey,
Thank you for your cooperation!

Annex XIII

Sample Picture of an Adult Loaded Camel

Source: IIED/SOS Sahel, 2010

Annex XIV

Sample Picture of the Salt Store Found in Berahle Woreda that Serve as a Market in Which the Salt Transported by the Salt Transporters is Exchanged and Stored

Source: Own Survey, 2013