1 INTRODUCTION

Approximately 25 % of the world's land surface support about 20 million households or about 180–200 million people in pastoral areas (Degen, 2007). Pastoral production systems are low external input systems that Kaufmann (2007) characterizes as probabilistic rather than deterministic, since outcome in such systems resulting from the inputs cannot be predicted with certainty. Although this applies to other agricultural systems as well, in pastoral systems the degree of uncertainty is higher particularly due to high temporal and spatial variability of resource availability. Moreover, several disturbance factors affect livestock production in the pastoral areas in the Sub-Saharan Africa. These include recurrent droughts, uncontrolled livestock diseases, inter-tribal conflicts and animal raids.

Pastoralists also receive few extension including veterinary services and have inadequate market access due to poor infrastructure (roads and telecommunication services). The pastoralists rely on their local knowledge to manage their animal genetic resources (AnGR). However, according to Wilson (2007) even though local knowledge is crucial for survival of the poor people, being agents of their own development is not enough. Moreover, pastoralists require external support in overcoming the impact of the extreme conditions of the disturbance factors like drought, diseases and conflicts. Pastoralists can cope with the disturbance factors when they are not extreme.

Pastoralists keep local breeds of camels, cattle, sheep, goats and donkeys that they largely depend on for their livelihood. Local breed is a livestock population in which livestock keepers ascribe member animals. The term "local" also denotes a breed's adaptation to the prevailing production conditions (Kaufmann, 2007). The local breeds are multi-functional in the pastoral production systems in Sub-Saharan Africa. They serve at meeting pastoralists' socio-cultural, subsistence and economic needs.

The high proportion of small ruminants in pastoral production systems in Africa attests their importance in pastoral areas. Lebbie and Ramsay (1999), for example, reported that sheep and goats constitute 28% and 34% of the total domesticated ruminant livestock in the Sub-Saharan Africa. Out of these 57% and 64% respectively, are found in the arid and semi-arid lands. Due to the short generation interval and high reproductive rate, sheep and goats are especially relied on when rebuilding herds after extreme droughts or animal raids. After the impact of these disturbance factors, small ruminants are exchanged with the large ruminants within the community or sold to outside market to buy the large ruminants.

It is widely recognized that local breeds of sheep and goats that have evolved under the harsh conditions in pastoral systems are well adapted to those conditions (Rege, 1992, Degen, 2007). The performance of the local breeds should therefore be assessed in their production context and not compared with exotic breeds out of this context. The relevance of the local breeds' traits is specific to their production system context.

Characterisation of livestock resources in their production system context entails identifying traits that are of interest to the livestock keepers, be it with regard to maintenance and reproduction of the herd, to utilisation of the livestock and their products and to livestock breeding. The livestock resources possess traits and show trait

levels that enable them to fulfill the respective functions. The livestock keepers' management influences the trait levels (Kaufmann, 2007). In this respect, the approach of characterizing animal resources in their production system context is an actor-oriented approach.

In the present study, sheep and goats genetic resources of the Gabra and Rendille livestock keepers were characterized in their production system context in Marsabit district, Northern Kenya. The main objectives of the study were:

1. To determine the functions of sheep and goats within the pastoral production system context in Marsabit District.
2. To exemplarily identify the management practices of sheep and goats.
3. To determine traits of sheep and goat populations that are relevant to the livestock keepers.
4. To quantitatively assess trait levels of relevant traits at population level in order to characterize the goat resources.

The study includes 6 major chapters. Following the current chapter, is the literature review. It covers pastoral production systems, local knowledge of pastoralists, small ruminant genetic resources, and characterisation of animal genetic resources. Chapter 3, deals with the materials and methods. The study area is first described. This is in terms of bioclimatic conditions, livestock, human demography, infrustructure and extension services. Also explained is the study design, theoretical model and data collection using both qualitative and quantitative research methods. Data management and analysis, which entailed qualitative and quantitative procedures, are also given. The results are presented in chapter 4. With regard to Gabra and Rendille sheep and goats, the results are given on age and sex classes, functions, management, relevant traits and preferred levels and animal types. Results on performance of goats are also presented, with regard to body condition of does, reproduction performance and milk yield. Chapter 5 deals with the discussion. It first covers characterisation and management of sheep and goats by Gabra and Rendille pastoralists. Secondly, performance of goat genetic resources under pastoral management of Gabra and Rendille pastoralists. Thirdly, productive adaptability and drought tolerance in the small ruminants. Fourthly, methodology for characterisation of animal genetic resources in their production system context. Summary of the whole study is given in chapter 6.

2 LITERATURE REVIEW

2.1 Pastoral production systems

Pastoral systems are classified into nomadic pastoral systems, and transhumant pastoral systems (Otte and Chilonda, 2002). In nomadic and transhumant pastoral systems, livestock is the only means of livelihood, whereas in agro-pastoral systems livestock and crop production are of varying importance (Wilson, 1991). While nomadic pastoralism entails high mobility of animals in search of grazing and water, transhumant pastoralism entails more or less regular seasonal migrations from a permanent homestead (Nicholson, 1984; Otte and Chilonda, 2002). According to Oba (1994), livestock and family movements may involve the whole or part of the household. It may also include the herd or flock splitting based on the species or productivity class.

Upton (1986) differentiated three sub-systems in the pastoral production systems: the natural resources (rangeland), capital (livestock resources) and management (pastoralists). According to Kaufmann (2007), pastoral systems are autopoetic systems. This means they reproduce themselves since the operations carried out by their elements lead to the elements reproducing similar elements. The structure of the system constitutes human elements (livestock keepers and their households), the operations (rules and actions) as well as animal elements (livestock) and their operations (behavior). Therefore, these are operationally closed systems as they depend on their autopoetic quality for their functioning. In other words, they rely on the internal structure for system internal operations to bring order in the system.

African pastoral systems are mainly found in the arid and semi-arid environments of West and East Africa and to a lesser extent in southern Africa (Nicholson, 1984; Otte and Chilonda, 2002). The arid areas have less than 75 days, and the semi-arid areas 75 to 180 days growing period (Seré and Steifeld, 1996). The arid and semi-arid environments that comprise 55% of the area of sub-Saharan Africa (Silanikove, 2000) are commonly referred to as rangelands. The vegetation ranges from open grasslands with little trees or shrub cover, to shrub communities with little herbaceous material, and to savannah woodlands where trees or shrubs form a variable layer over a grassy understory (Ash and Maclvor, 2005). Nutrition of the animals is based exclusively on access to, and exploitation of natural pastures and browse (McDermott et al., 1999)

Rangelands have marked fluctuations in resource availability and have extended dry periods that last usually about 10 months and sometimes even more (Silanikove, 2000). Primary productivity in rangelands shows temporal (both years and seasons) and spatial variation depending on the amount of rainfall received in the different areas. This heterogeneity leads to fluctuation in stocking densities and hence grazing pressure (Cossins, 1987; Otte and Chilonda, 2002).

2.1.1 Pastoralists

Pastoral societies are defined as people that raise livestock on communal land using natural rangelands as the main forage for the animals, and for which animal husbandry is economically and culturally dominant (Galaty and Johnson, 1990; Degen, 2007). In pastoral systems, livestock resources are the centerpiece for the daily and ceremonial

life and are the principle currency for social and commercial transactions (McDermott et al., 1999). In East African pastoral systems, multiple livestock that include camel, cattle, goats, sheep and donkeys are kept. The balance among them varies according to regional ecological differences (Sato, 1997).

Through livestock, management pastoralists obtain different products and services from the animals (Spedding et al., 1981). According to Kaufmann, (2007 3003) livestock management can be subdivided into the following activities:

- Maintenance management, which facilitates animals to live and reproduce.
- Utilization management that uses the animal's metabolism.
- Breeding management that influences the trait expressions of the animals of the next generation.

Livestock management practices in pastoral systems are characterized by three principles; adaptation to the environment in the attempt to ensure production, risk averting strategies and adaptation to the institutional environment (characterized by communal grazing system) (Jahnke, 1982). Some of the risk averting strategies have been described (Jahnke, 1982; Cossins, 1983; Sandford, 1983; Swift, 1996; Kaufmann, 1998) and include:

- Mobility (vary both by length and time of the year with either the whole herd or part of it, mainly in search of forage and water).
- Livestock diversity (keep more than one species in order to make best use of the total vegetation and the diverse characteristics like walking ability, hardiness and milking ability).
- Herd splitting (provided there is labour herds are split into different management units in order to spread risk and exploit distant pastures, or poorer members in the community are loaned some animals by livestock keepers having large herds).
- Restocking procedures (keeping of mixed herds in order to use small stock in re-diversifying the herds with large stock in post drought years; relatives lend animals to households that have lost their animals through diseases or theft, and thus ensure reciprocity in times of need).
- Grazing reserves (designated areas for grazing during dry seasons and prolonged drought periods).

2.1.2 Production constraints

Cossins (1983) provided a set of three constraints that require pastoralists to diversify their production strategies in order to cope with the constraints. These were:

- Variability in resource availability: these are constraints resulting from mostly seasonal events. A normal year oscillates between times of plenty (the rains and post rain periods) and times of scarcity (the dry seasons). Peaks of diseases, parasites and forage vary with the seasons in a year.
- Disasters: these include epidemic diseases, range fires in the dry season and drought.
- Long-term changes: these may include loss of the dry season grazing reserves to cultivation or other sectors, loss of livestock to raids and unfavourable government policies.

While some of the variations such as the occurrence of wet and dry season can be predictable, length of dry season, amount of rainfall in wet season and outbreak of diseases are difficult to predict (Upton, 1985). Heat together with water scarcity is a major constraint to animals' growth, milk production and reproduction performance in arid areas (Silanikove, 2000). Livestock depend on limited water from either natural springs or shallow wells, and deep wells sometimes. In a number of arid regions in the developing countries, deep wells have been placed on land formerly underutilized by stock. Without regulation of animal numbers and grazing periods, degradation of the range resource has occurred around some of the water sources (Brown, 2003).

Drought, inter-tribal conflicts and disease outbreaks are phenomena that frequently decimate pastoralists' herds/flocks (Hogg, 1987). Failure of rainy seasons leads to drought in arid and semi-arid lands regions. Hence, vegetation cannot recover from the dry season state and consequently forage gets very limited. This leads to reduction in livestock production, and often to high losses (Horn et al., 2003). Drought appear to be increasing in frequency in Sub-Saharan Africa, and thus pastoral families are in a constant state of "recovery" from the last drought and seldom get a chance to re-establish the previous status quo based on large stock (Peacock, 2005).

Drought in Northern Kenya was identified to have contributed to increased household wealth inequalities (Fratkin and Roth, 1990). Pastoralists' drought management strategies, which may include the diversification of species and activities, or herd splitting, are geared towards reducing losses from drought (Wallis, 1991; Reckers, 1994). Response to drought strategies may entail increased mobility, labour migration, selling of assets, or intensification of available resource use (Wallis, 1991).

Warfare and armed conflicts have threatened pastoral livestock production in Northern Kenya. Competition and co-operation are a normal part of pastoralist livelihood strategies, which sometimes break down in times of hardship leading to conflict and raiding of stock from neighbouring tribes (Berger, 2003).

McDermott et al. (1999) considered epidemic diseases, in addition to zoonotic diseases, as more important than production diseases in the pastoral extensive systems. They attributed transmission of epidemic diseases to the large, mobile and mixing livestock populations of the pastoralists. Delivery of animal health goods and services in pastoral areas is constrained mainly by high transaction costs that are attributed to livestock movement (McDermott et al., 1999).

2.2 Local knowledge

Local knowledge encompasses knowledge, talents, skills and techniques that are held by farmers in their different agricultural systems and transmitted orally across generations (Altieri, 1991; Puffer, 1995; Komwihangilo et al., 2007). Different terms, mainly traditional knowledge and indigenous knowledge, are often used interchangeably to denote local knowledge (Rajasekran, 1993; van Vlaenderen, 2000). However, what is understood exactly by local, indigenous or traditional knowledge is specific to the observer depending on her or his consideration of what the terminology entails (Antweiler, 1998).

The term local focuses on the cultural and ecological context in which the knowledge is used rather than geographical or area specificity (Antweiler, 1998; van Vlaenderen, 2000). It was indeed shown by Sinclair and Joshi (2000) that knowledge of famers, who live in two different geographical areas, but with similar agro-ecological conditions, had notable similarities. Such a resemblance of local knowledge in similar agro ecosystems is for example, given by Thorne et al. (1999) in an account of similarity in local criteria of evaluating and deciding on fodder tree feed resource amongst farmers occupying hillsides in Kenya and Nepal.

Local knowledge relying on contemporary observations, creativity and experimentation is dynamic and constantly incorporating outside influences and inside innovations (Langill, 1999; Sinclair and Joshi, 2000). Therefore, local knowledge within a community continues to be developed and adapted continuously to a gradually changing environment, embracing exogenous knowledge that has entered over time (van Vlaenderen, 2000; Kabudi, 2003). Antweiler and Mersmann, (1996) distinguished local knowledge into declarative, procedural and complex forms (Table 1):

Table 1: Forms of local knowledge and related examples

General forms of local knowledge	Examples
1. Declarative knowledge	
• Factual knowledge	Animals, plants
• Categorical knowledge	Categories of organisms, colours
2. Procedural knowledge	
• General processes, rules	Events calendar, religious calendar
• Specific processes ("scripts" schemes, plans)	Everyday routine, e.g. greetings and farewells, natural resource management, ritual sequences
3. Complex knowledge (concepts, belief systems/knowledge systems).	Cropping systems, decision-making procedures, animal husbandry systems

Adapted from (Antweiler and Mersmann, 1996)

Local knowledge forms the main driving force for rural people's decisions making on land use, food production, community management, health practices, religious practices, teaching, learning and experimenting, (Antweiler, 1998; Miller, 2004). It is therefore a major point of articulation for development activities. Farming systems across the African continent indeed are characterized by deliberate maintenance of diversity in domesticated animals and local knowledge systems that contribute to conservation of these genetic resources (Warren, 1992; Rajasekran, 1993).

According to Puffer (1995), local knowledge is important for the researcher or scientist for several reasons:

- Represents the ways in which people have dealt with their environment.
- Familiarity can help extensionists and researchers understand and communicate better with local people.
- It can facilitate in identifying the appropriate solution to development.

Limitations of local knowledge systems have been elucidated by Rajasekran (1993). They include:

- Indigenous knowledge systems are of oral nature.
- Local knowledge systems are not formally recorded and documented.
- Each individual possesses only part of the community's local knowledge systems.