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Socioeconomic factors affecting the occurrence of the parasites in goats kept in Angola

Diploma Thesis

Department of Animal Science and Food Processing in Tropics and Subtropics

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Declaration

I hereby declare that the thesis „Socioeconomic factors affecting the occurrence of the parasites in goats kept in Angola” has been written by myself, I used only initiate sources and literature without any external unauthorized help.

Prague, 2012 Signature

Abstract

A study was carried out in seven villages in municipal Catabola (Angola, Province Bié) to search gastrointestinal parasite situation of bred goats to test the possible influence of socioeconomic correlates. Faecal samples for worm egg counts were collected per rectum from 37 adult goats (females) in selected flocks of goats, in each of seven villages. The study was conducted during rainy season (September – February) 2010. The gastrointestinal parasite infecting goats were, in order of predominance: Coccidian parasites (*Eimeria* spp.) with prevalence of 98.52% Strongyle-type eggs with prevalence of 98.52% and larvated eggs of *Strongyloides* spp. with the same prevalence. Trematoda were not identified in the study area. Prevalence of *Moniezia* spp. a *Trichuris* spp. and pulmonary parasitic nematods in samples among villages were significantly different (Kruskal-Wallis test, $p < 0{,}04$) but overall parasite prevalence, Strongyl-type egges, *Strongyloides* spp. and Coccidian parasites did not differ. By multiple regression analyses was found out that villagers' literacy, size of village and the number of goat´s keeper influence number of goats bred in villages. Other analyze shows high correlation between the number of kept goats and pigs ($r = 0.95$), the number of goats and chicken ($r = 0.85$) and the number of goats and ducks ($r = 0.76$). The multiple regression models showed a significant influence especially in pigs and also in chicken and pigeons on prevalence of *Trichuris* spp. By multivariate model Principal Component Analyses (PCA) was tested the interactions of the prevalence in all studied parasites on several independent variables (e.g. mortality and natality of goats, goat origin, keeper´s literacy, breeding of other livestock, etc.). PCA revealed that prevalence of coccidian parasites, *Strongyloides* spp., and order Stongylida are highly positively correlated in comparison to Plumoes nematodes, *Moniezia* spp., *Trichuris* spp. The results are discussed with other studies conducted in SSA, but only the part about parasite prevalence other results as influence of socioeconomic correlates to gastrointestinal parasites was discussed only by myself.

Keys words: Bié, coproparasitological exam, gastrointestinal parasite prevalence, Sub-Saharan Africa.

Abstrakt

Výzkum byl proveden v sedmi vesnicích v okrese Catabola (provincie Bié, Angola) s cílem identifikovat gastrointestinální parizity chovaných koz a testovat možné korelace mezi jejich výskytem a socioekonomickými faktory chovatelů a vesnic, kde žijí. Fekální vzorky byly odebrány z rekta 37 dospělých koz ve všech sedmi vesnicích. Analýza byla provedena v období dešťů (září – únor) v roce 2010. Byly zjištěny následující skupiny gastrointestinálních parazitů: kokcidie (*Eimeria* spp.) s prevalencí 98,52 % a vajíčka zástupců řádu Strongylida se stejnou prevalencí. Přítomnost Trematoda nebyla v oblasti zjištěna. Prevalence *Moniezia* spp., *Trichuris* spp. a plicních nematodů byla výrazně odlišná (Kruskal-Wallis test, $p < 0,04$), avšak celková prevalence parazitů, parazité řádu Strongylida, *Strongyloides* spp. a kokcidie se nelišila. Dále bylo pomocí regresní analýzy zjištěno, že s úrovní gramotnosti vesničanů, společně s hustotou osídlení vesnic a počtem chovatelů koz roste počet chovaných koz ve vesnici. Další analýza poukazuje na vysokou korelaci mezi počtem a druhy chovaných hospodářských zvířat: mezi počtem chovaných koz a prasat ($r = 0,95$), mezi počtem chovaných koz a slepic ($r = 0,85$ %) a počtem chovaných koz a kachen ($r = 0,76$). Následná mnohonásobná regresní analýza ukázala významný vliv mezi výskytem *Trichuris* spp. v souvislosti s chovem prasat, slepic a holubů. Pomocí vícerozměrného analytického modelu - Analýzy hlavních komponent (PCA) byly testovány interakce celkové prevalence parazitů na několika zavislých proměných (např. mortality a natality koz, původu koz, úrovni gramotnosti chovatelů a odlišnosti v chovu ostatních hospodářských zvířat, atd.). PCA ukázala, že prevalence kokcidií, *Strongyloides* spp., a vajíčka parazitů řádu Strongylida spolu pozitivně korelovala ve srovnání s prevalencí plicních nematodů, *Moniezia* spp. a *Trichuris* spp. Výsledky týkající se prevalence parazitů byly diskutovány s odbornými studiemi zaměřenými na výskyt parazitů v subsaharské Africe. Ostatní výsledky – vliv socioekonomických faktorů na výskyt parazitů u koz - byly diskutovány pouze autorem této práce, a to z důvodu absence odborných studií na toto téma.

Klíčová slova: Bié, coproparasitologický test, Catabola, prevalence gastrointestinálních parasitů, Subsaharská Afrika.

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List of abbreviations

CAU – Czech Agriculture University

FAO – Food and Agricultural Organization

FECs – Average faecal worm egg counts

GDP – Gross domestic product

GI – Gastro intestinal

GIN – Gastrointestinal nematode

GIP – Gastrointestinal parasite

IEMVT – Institut d'Elevage et de Medecine Veterinaire des Pays Tropicaux

PCA – Principal components analysis

PCCA – Principal Components and Classification Analysis

SSA – Sub-Saharan Africa

SSAAQ – The Sub-Saharan Africa Activity Questionnaire

WHO – World Health Organization

Introduction

In majority of African countries the poverty is higher than in other countries in the developing world. In Sub-Saharan Africa (SSA) 150 million people live on less 1 USD per day and 105 million poor people in SSA are at least in part dependent on livestock to sustain their livelihoods (World Bank, 2002) (see map of poverty distribution on the World, Appendix 1). One way how in these area reduces poverty is rearing livestock (in the poorest area goats and sheep) it can contribute by increasing food supply, produce other products such as wool, skins and milk and by their adaptability to varying environmental conditions. In addition goats and sheep are often used to settle debts (dowry, loans, traditional fines etc.).

On the other hand raring goats have one big constrain, it is goats susceptible to gastrointestinal parasite infection and other tropical diseases. “There are many important diseases of sheep and goats,” notes University of Georgia researcher Ray Kaplan, DVM, Ph.D., “but none are as ubiquitous or present as direct a threat to the health of goats as internal parasites” (Kaplan, 2004).

This collection of papers represents a broad overview of goat population in SSA and its importance for rural people, goats main constrains predominantly gastrointestinal parasites. Main part of survey is focused on influence socioeconomic factors of areas and goats keepers to gastrointestinal parasite prevalence of goats. Other part of study is conducted on parasitological overview in Catabola (Angola, province Bié). There is no a substantial body of evidence showing that socioeconomic factors of goat´s keepers and/or village can influence amount of gastrointestinal nematode parasites occurs in goats. This paper reports a study that investigated socioeconomic factors which could influence prevalence gastrointestinal nematode parasites predominantly coccidian parasites (mainly *Eimeria* spp.), trematoda (mainly *Fasciola* spp., *Dicrocoelium* spp), *Moniezia* spp., *Strongyloides* spp., *Trichuris* spp., nematodes of the order Strongylida and lung worms larvae of adult goats in municipal Catabola (province Bié, Angola).

1. Literature review

1.1. Importance of goat breeding in SSA (Sub-Saharan Africa)

In developing countries including Sub-Saharan Africa livestock is one of many paths that lead to the country development and in many areas for rural people it is the only possible way of living. The importance of livestock, especially small ruminants, in rural area is evident from Ashly et al. (1999), which noted that roughly 70 per cent (or 150 million people) of the rural poor people in SSA are dependent on livestock to sustain their livelihoods. Wilson et al. (1991) presents that tropical Africa has got one-third of all world´s goats and one-sixth of sheep, this fact confirms Kanani et al. (2006) and Wilson et al. (1991) continues that on average, there is one goat or sheep on every 10 ha of tropical Africa and there is 1.1 head of goats and sheep per person employed in agriculture. Following chapters (1.1.1., 1.1.2., and 1.1.3.) are focused on this topic with more detail and also describe goats breeding benefits for rural people in SSA.

1.1.1. Adaptation and integration of goat in SSA systems of production

The importance of the goat role in the fight against hunger and poverty has been well stated by many researchers. Peacock et al. (2005) noted that, goat breeding is an integral part of the poor population in every environment on the continent, belongs to their culture and guides them from generation to generation. Lebbie et al. (2004) agrees with his opinion and adds her contribution seriousness to his work. She writes about the special attributes of goats that make them particularly important in rural areas in SSA compared to other domestic animals. The best description how well are goat adaptive for live in SSA conditions and goat´s importance for rural households presents Lebbie et al. (2004) and Wilson et al. (1991). Lebbie emphasizes the following goat's benefits: *"the ability to walk long distances, short generation intervals and high reproductive rates, high turnover rates on investment and hence low risk on investment, high energetic efficiency of milk production, and efficient utilization of marginal lands, smaller carcasses which are conveniently marketed or consumed over a short time period."* She also noted that goat breeding is important in rural area, where is not possible to store raw meat because in rural area people do not have access to energy.

Another very important factor for prefer goat breeding is their highly adaptation to a broad range of environments.

Other authors like Kanani et al. (2006) emphasizes uniqueness of the importance of goat breeding in the humid tropics where cassava and other tuber are the staple crops, goat's meat can provide the necessary protein to the human diet. Peacock, et al. (1996) on the other hand focused his study on goat's appearance to withstand drought better than cattle. This finding confirms a study from Ethiopia and the Sahel, including Sudan, which had done by Wilson et al. (1991). This study improved the goat resistance comparing with cattle. During the droughts in 1980s cattle losses were 80% while those small ruminants, including goats, were not more than 50%. Additional goats are milking during dry season when cattle did not get enough fodder to produce sufficient milk mentioned Kanani et al. (2006).

Leeuw et al. (1995) have other point of view on significance of breeding small ruminants in SSA. He mentioned that important role of livestock in rural SSA is providing sustenance, cash income, and insurance abstain risks in difficult environments, transportation, animal traction and manure.

1.1.2. Distribution and importance of goat population in SSA

Distribution of goats is strongly influenced by environmental conditions especially by the climate type. Leebie et al. (2004) describes the high distribution and strong growth of goat population in SSA according to environmental zones. She mentions that arid and semi-arid zones hold 64% goat population but humid and the highland zones have 10% and sub-humid zone accounts 17%. Table 1 and Figure 1 show the climate type in Angola. Area of the study, municipal Catabola is situated in province Bié in humid areas. According to authors survey in this area was calculated that every family rears in average 3 goats.

Table 1: Climate type in Angola (Diniz, 1998)

Tipe climate	**Area (km2)**	**% of total**
Arid (E)	62 320	4,99
Semi-arid (D)	174 200	13,97
Sub-humid dry (C1)	152 300	12,22
Sub-humid rainy (C2)	144 920	11,62
Humid (B1, B2, B3)	712 960	57,2
Total	1 246 700	100

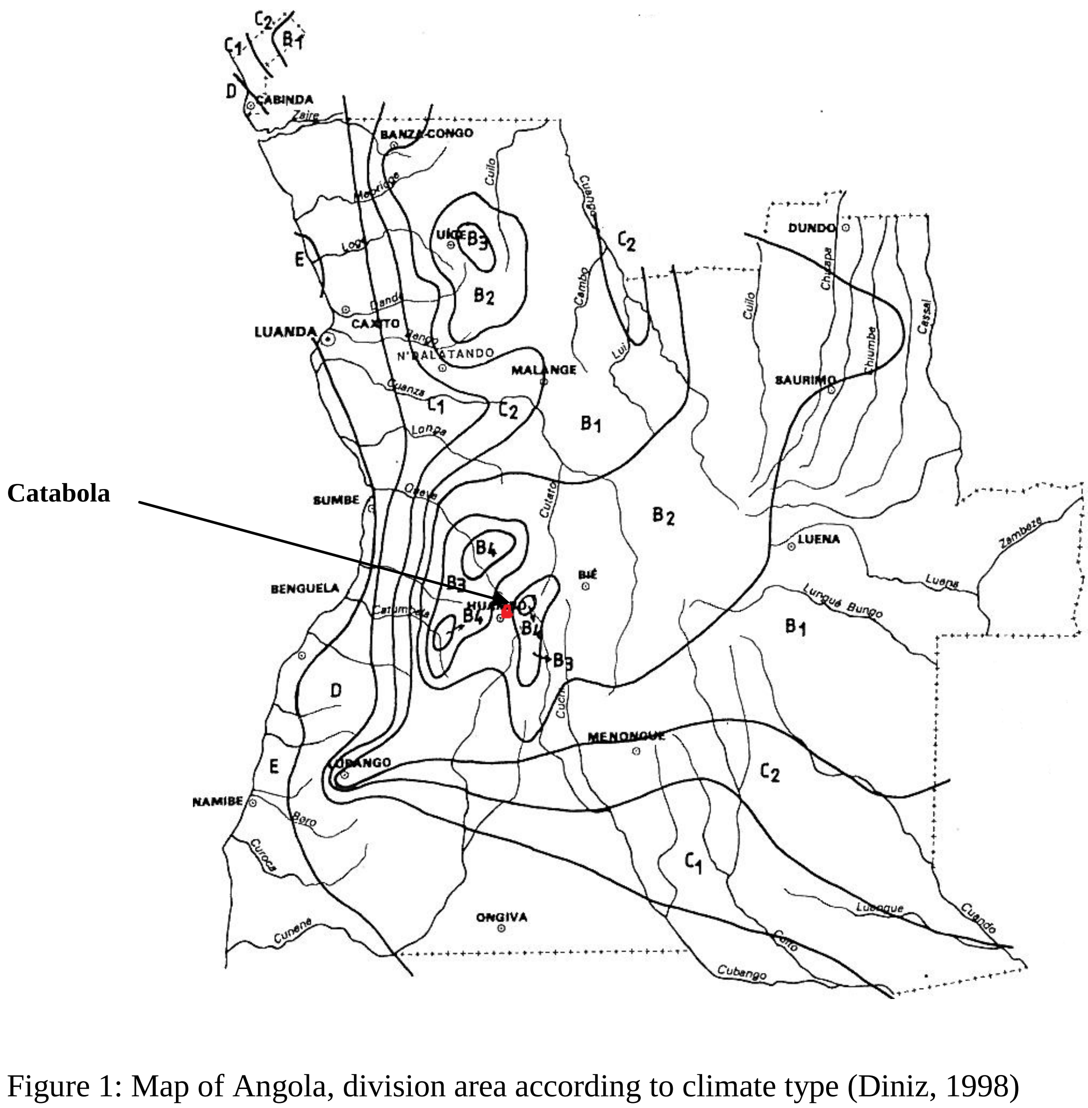


Figure 1: Map of Angola, division area according to climate type (Diniz, 1998)

Leeuw et al. (1995) shows other division of main livestock production systems in SSA regions. He describes that the importance of livestock wealth as a source of income and subsistence decreases inversely with increasing rainfall. According to

Wilson (1988) there are several major criteria for assessing the distribution and importance of goats: density per unit area and ratio of goats and sheep to human population in agricultural activities. Figure 2 demonstrates densities of small ruminants in SSA and ratio of small ruminants to people in agricultural activities. This figure shows that goat breeding is abundant almost in all SSA. The high densities are found almost in all Africa. There are states with more than 35 goats and sheep/km^2. It is in the Horn of Africa, in Somalia and Djibouti, in Ethiopia central African highland republics of Burundi and Rwanda. Although the density of goats including sheep's less than 7 goats and sheep/km^2 it could be sufficient to people density in those areas (included Angola) as we can see on the ratio of goats and sheep's per person (see Figure 2).

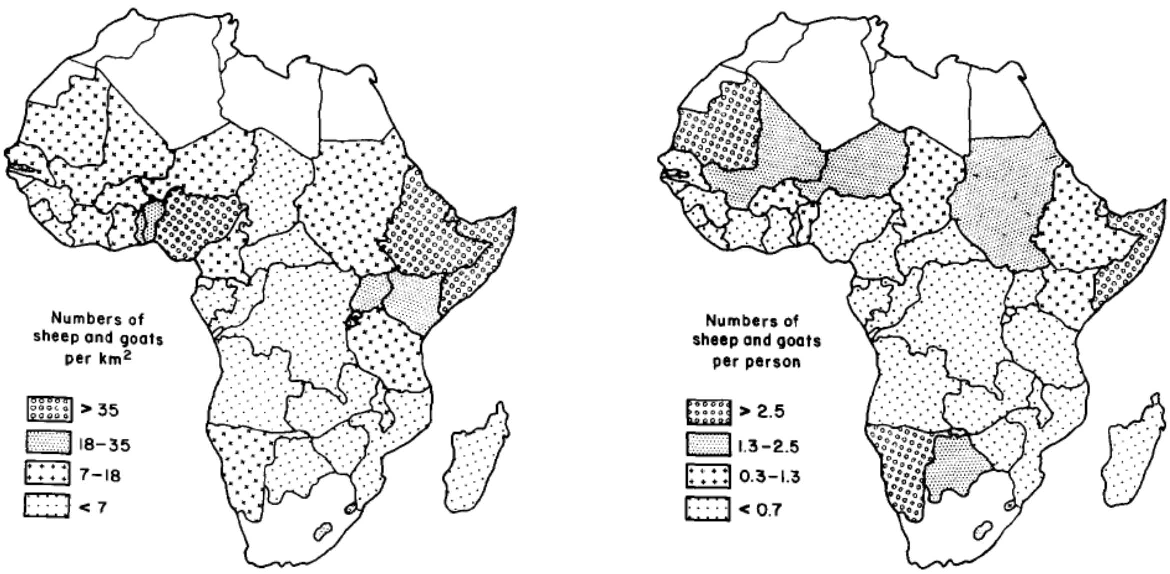


Figure 2: Density classes of small ruminants and Ratios of small ruminants (goats and sheep combined) to people in tropical Africa (Willson, 1988).

The goats are mostly kept by rural farmers where they serve for multiple purposes. These farmers breed about 70% of the livestock mass in SSA and furthermore, rural households own more than 90% of the goats (Boyazoglu et al., 2005).

This information is added by Mahmoud´s opinion. Mahmoud et al. (2010) noted that increasing and high goat population number does not necessarily indicate a positive development of productivity, but reflect the fact, that rural people in developing country try to survive by keeping goats. Adding, Ogle et al. (1996) mentioned that SSA has the great pastoral potential due to extensive pastures which are the biggest permanent pastures of any continent with largest number of pastoralists.

Table 2 compares livestock inventory of different continents in goat, cattle and sheep based on several authors. It is obvious that livestock production has a big tradition in Asia and Africa (mainly in SSA).

Table 2: World´s estimated livestock population

Continent	Inventory (million head)		
	Goat	Sheep	Cattle
SSA[1]	147	127	162
SSA[2]	166.8	164.2	194.9
Africa[3]	291.1	287.6	
Asia[4]	514.4	452.3	
Northern America[5]	3.0	6.9	
Central America[6]	9.0	8.1	
South America[7]	21.4	73.1	
Caribbean[8]	3.9	3.1	
Europe[9]	18.0	133.9	
Oceania[10]	0.9	113.1	
World[11]	861.9	1078.2	

1.1.3. Distribution and importance of goat population in Angola

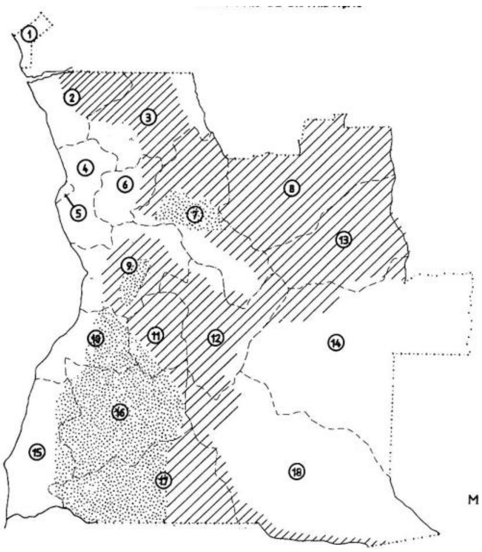
This topic is discussed with Diniz (1998), who describes goat breeding area in Angola according to suitable climate conditions for goats and according to real prevalence of goats in each province (see Figure 3 and 4).

Diniz (1998) notes that in Angola goat population is mainly distributed in rural areas. His maps represent the area with more goat distribution in Angola, the provinces are Huila and Cunene and for the various surfaces of plateau Bengela, Kwanza Sul and Malange. Outside these areas the incidence of goat dispersion is quite notorious on the thinning areas of dense forest in the humid and goats disappearing because goats were

[1] Winrock (1992)

[2] FAO (1997)

[3, 2, 5, 6, 7, 8, 9, 10, 11] Mahmoud (2011) affected by *Glossina*. Other map (see figure 4) represents parts of the territory in Angola more favorable for goat breeding from of climate and the quality of pastures point of view. They are roughly within the boundaries of the provinces of Hiula, Cunene with the extensions in the north to the planalticos levels in Bengela and part of Kwanza Sul and in the valley southeast of the Okavango.



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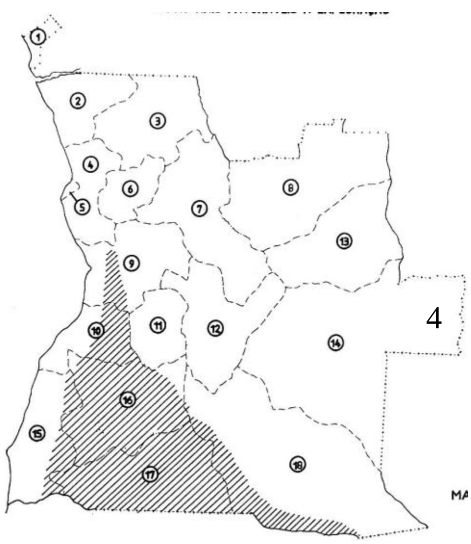

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Figure 3: Area with more goat prevalence in Angola

Figure 4: Area with the most sustainable condition for goat breeding in Angola.

1.1.4. Role of goats in household economies in SSA

A strong argument that livestock contributes significantly to economic growth reflects the finding of Ehui et al. (2002). He wrote that livestock production currently contributes about 35% of agricultural gross domestic product (GDP) in SSA and if non-food products and services were added this share would even be higher. Otte and Knips (2005) mentioned that the production of eggs, pork and poultry meat in SSA tripled between 1970 and 2000. Milk and goat meet doubled and beer increased by 70 per cent. Restani et al. (2004) highlights importance especially dairy goats, which are ideal species for poverty reduction and economic development mainly due to their attractivity for improvement of family food security and livelihood of the poor in developing countries. Peacock et al. (2005) emphasizes same following benefits as: "*Goats are easily acquired by the poor as they require modest starting capital. They can easily be tended by the weak, women or children. They provide people by valuable nutrients.*

Many people cannot drink cow milk as they are allergic to it. Several studies indicated that people with cow's milk allergy could tolerate goat's milk. The growing demand for goat meat presents an opportunity for goat fattening." The Table 3 presents annual output of meat, milk and skins in 1995 by African sub regions.

Table 3: Estimated value of annual output of meat, milk and skins from African ruminant livestock by sub regions Rege and Lebbie (2004)

Species	Product	Value (million US$)					Total
		Eastern Africa	Southern Africa	West Africa	Central Africa	North Africa	
Cattle	Meat	4293.5	1611.4	1616.7	722.5	634.0	8878.1
	Milk	2647.1	534.5	424.2	144.4	277.0	4027.2
	Hides[c]	78.6	24.2	30.2	10.6	7.6	151.2
Sheep	Meat	740.6	391.8	422.2	101.3	878.1	2534.0
	Milk	343.8	0	40.7	9.8	142.5	536.8
	Skins[c]	36.9	17.4	21.7	4.3	28.2	108.5
Goats	Meat	732.5	189.1	598.8	146.5	251.2	1918.1
	Milk	467.6	4.9	112.0	20.3	120.5	725.3
	Skins[c]	35.6	8.7	28.6	6.1	7.8	86.8
Sub-total	Meat	5766.6	2192.3	2637.7	970.3	1763.3	13330.2
	Milk	3458.5	539.4	576.9	174.5	540.0	5289.3
	Hides/skins	151.1	50.3	80.5	21.0	43.6	346.5
Total		9376.2	2782.0	3295.1	1165.8	2346.9	18966.0

Rural people do not have access to banking facilities, goats provide security against crops failure and currency fluctuations, and are used only when necessary to meet family needs. Other important goat products are goat urine and manure that serve as an organic (low-imput) fertilizer for improving agricultural production. The most of poor people can not afford the expensive inorganic fertilizers as wrote Wilson *et* al. (1986). In addition Lebbie et al. (2004) mentioned that goats can convert household waste, crop residues into hight value commodities, they also graze on uncultivated parts of farm thus transform wasteland too hight value commodities and do not need to be fed, mainly in reany season. According to Whaley et al. (2002) it is well known that animal products can play big role in healthy child development as well as in adult health. Goat breedinghave positive impact on certain key micronutrient deficiencies (Ayele et al., 2003).

1.2. Constrains of goats breeding in SSA

Studies of small ruminants are less numerous than those about cattle. One of the best overview wrote Lebbie et al. (1994, 2004). Similarly Kanani et al. (2006) mentioned lists with main constrains as: organization linked issues (e.g. insufficient husbandry), inadequate breeding stock, deficit or poor inputs, no markets, poor infrastructure and lack of well-organized information networks, no healthy policy for animal in rural areas, etc. The most important biological constraints to small ruminant in the all agro climatic zones in Africa are diseases. Loss of production, high levels of mortality and the cost of drugs are some of the major concerns (Bester et al., 2009). Lebbie et al. (1994) added, that seriousness treat in goat breeding in Africa follow after high prevalence of diseases and parasites inadequate nutrition, unprofessional management and breeding. It was her, who gave the most comprehensive overview about the goat breeding constrains.

1.2.1. Parasitism

Parasitism ranks high among the factors that limit the productivity of small ruminants although its effect is often underestimated. Helminthiasis was the most prevalent condition encountered. Same study from the Ghana found, that 80% of the sheep and 88, 3% of the goats were infected by the helminthes (Lebbie et al., 2004).

1.2.1.1. Helminthiasis

One of the studies of FAO (1992) points out that helminth infections remain one of the major disease constraints to small ruminant production. Survey indicates that up to 95% of sheep and goats are infected with helminths. According to IEMVT (1980) the most striking effect of helminth infection in small ruminants is death of the host. Mortality rates can exceed 40% while weight loss of 0.6 - 1.2 kg/year/animal may occur. Adding helminth infections, which cause economic losses, have other imminence - several helminth infections can be transmitted to human (zoonoses) (Over, 1992).

In the literature there are many articles about losses caused by helminth infection in SSA. There are few published estimates but they suggest that production losses are generally high. Graber et al. (1975) studied loss of goats and sheep in Chad due to gastrointestinal nematodes and found that total annual loss was 11,3% of total economic value of those animals. Other study from Brito (1947), found down an annual mortality rate of 54% an additional 12% due to combined effect of helminth and coccidial infections. This issue is described with more detail in chapter 1. 3. Gastrointestinal parasites of goats in SSA.

1.2.1.2. Coccidia

Coccidian parasites are the most common GIP in ruminants together with helmithiasis as wrote Maingi et al. (1993) and Waruiru et al. (1993). Chartier (2011) added the information about the fact, that Coccidiosis of small ruminants has great economic importance because of the losses due to clinical disease (diarrhoea) and subclinical infections as well (poor weight gain in particular). A survey of Kussiluka *et* al. (1996) conducted to prevalence and type of coccidian species in small ruminants in Tanzania and found out that 191 goats from 210 were infected by coccidia. Other study form Ghana, made by Agyei *et* al. (2004) says, that all the goats kids passed out *Eimeria* oocysts and oocysts were seen as early as 20 days after birth and high oocyst counts ranging between 1.5 and 2.7 million per gram of faeces. There were 70% representing a total of 14 kids died during the study period (1,5 year).

Goats are also suffering with others disease and parasites but this thesis is focused on Heminths and coccidian parasites, therefore following chapter describes these other threats only briefly.

1.2.2. Ticks, tick-borne and other diseases

The tropical African climate is favorable to most major vector-borne diseases, including: malaria, schistosomiasis, onchocerciasis, trypanosomiasis, filariasis, leishmaniasis, plague, Rift Valley fever, yellow fever and tick-borne haemorrhagic fevers (Githeko et al., 2000). Lebbie et al. (2004) added that the two most serious vectors which transmitted parasites are ticks and mites.

Tick-borne diseases of goats and sheep in Africa include babesiosis, theileriosis, anaplasmosis and ehrlichiosis (Bester et al., 2009). Tick-borne parasitic protozoa are differentiated into the genera *Theileria* and *Babesia*. The economic losses thanks theileriosis and babesiosis are very high in tropical and subtropical areas as in SSA (Mehlhorn et al., 1994).

About 46% of tropical Africa is infected by *Glossina* spp. with the highest infestation in the humid (90%) and sub humid (68%) zones. It has been generally believed that small ruminant breeds adapted to the humid zones are trypanotolerant (Lebbie et al., 2004).

1.2.3. Nutrition

All studies considering with this theme come to the same conclusion, that in SSA the inadequate feeding is one of the major limiting factors to small ruminants' production. Insufficient nutrition can cause high annual mortality rates that can range from 30 to 50% in young stock and 10 to 30% in mature animals (Kolachhapati et al., 2005). The fodder has poor nutritional value due to the rainfall pattern for most of the year. Main feeding of goats is grazing and browsing on natural pastures and because of rainfall seasonality, the quality and quantity of feed is very poor in dry season which results in low digestibility and low voluntary intake by animals. In this case diet must be supplemented. Typical example may be in the form of trace mineralized salt, individual sources of calcium and phosphorus (Tolera and Abebe, 2007).

According to many reports in the literature it is generally known that the plane of nutrition is an important determinant of parasites and also influences the size of their pathogenic effects and prove to the synergistic association between helminth infection and malnutrition. The fodder supplementation, mainly with high quality protein is often necessary to sustain adequate efficiency of livestock on such poor quality feed, but the cost implicated makes this opportunity quite unrealistic for the most of livestock farmers in the developing world (Waller, 1997).

1.2.4. Management

In SSA small ruminants are kept under traditional extensive systems. Different groups of grazing animals according to zone were found out. In the arid and sub humid zones, cattle are reared with sheep and goats. In the humid zone, animals generally graze freely, with access to household and kitchen sates when available. These are supplemented with bush grazing on low quality forages or browses (Pell, 1999). Leebie et al. (2002) devoted big attention to this topic and elaborated them with detail. She emphasizes following characteristics of sheep and goat management under traditional systems: "*stock owners are usually crop farmers (mostly arable crops in the arid and sub humid zones and tree crops in the humid zone) for whom livestock keeping is of* *secondary importance; most households keep only a few sheep and goats, also keeping other livestock such as pigs, horses, chickens and domestic animals such as cats and dogs; the flock structures do not reflect good breeding strategy; veterinary and livestock improvement services are minimal; and the management systems are not integrated with crop production."* Leebie et al. (2002) evaluates this management practices as inconvenient because of several reasons; mortality rates (particularly amongst the young) and losses from accidents, theft and predators are high. Research innovations and extension services have a little impact on the production systems, therefore the benefits of an integrated crop/livestock production system are lost.

1.3. Gastrointestinal parasitic helminthes of goats in SSA

Goats are markedly vulnerable to infectivity with gastrointestinal nematodes though the occurrence of antihelmintic resistance is higher than in sheep, with which they share the same nematode parasites (Waller, 1997). Fabiyi (1987) reported that gastro-intestinal (GI) parasitosis causing by nematodes represent one of the most significant disease constraints to goat production in the SSA. In the extreme situations of subsistence farming, where anthelmintics are either unaffordable, or of such inferior quality that they are not used by the stock owner, massive mortalities of young stock caused by internal parasites are still, tragically a commonplace phenomenon, particularly in countries of Africa and Asia (Waller, 1997).

1.3.1. Parasitological helminthes surveys in SSA

There are many studies investigated on GIP in SSA. For the part literature review author choose surveys which have similar attributes as same kind of parasites, same host, similar methodology etc. First interesting study was written by Baker *et* al. (2001). This survey was investigated on genetic variation for resistance to GI nematode parasites (*Haemonchus contortus*) of kids between and within the Galla and Small East African (SEA) breeds in the sub-humid region of Kenya. Other study is from Namibia by Kumba et al. (2003). The author focused on seasonal evolution of faecal egg output by gastrointestinal worms in goats on communal farms in eastern Namibia. This study compared occurrence of GIP with changing seasons during whole year and found that the FECs followed a three-pronged trend, during the warm-wet season (January, February, March and April) being highest in most villages, much lower in cold-dry season (May to September) and intermediate for the hot-dry months (October to December). The similar research was done in Uganda by Magona et al. (2002). His team carried out study about influence of age, grazing system, season and agroclimatic zone to the prevalence and intensity of GI strongylosis in goats. They collected 1661 feacal goats' samples from 4 different climatic zones between 1996 – 1997 and come to results that grazing system, agroclimatic zone and agroclimatic zone were the unique factors found to have a significant influence to the intensity of GIN infection, age did not. On the other side age played significant role together with grazing system, season and agro climatic zone in influence on the level of risk of nematode infections. Other survey was conducted in South Africa by Maingi et al. (2006) and focused on the effectiveness of selective anthelmintic treatments and use of nematophagous fungi *Duddingtonia flagrans* in reducing levels of gastrointestinal nematodes in goats. It was found out that the most abundant species infecting animals were *Haemonchus contortus* and *Trichostrongylus* spp. and were higher in the fungi fed group. More animals required individual anthelmintic treatments in the no-fungi fed group. In Cameroon Mbuh et al. (2008) realized survey focused on effect of parasites of sheep and goats and their prevalence in Bokova, a rural area of Buea Sub Division. Investigations exposed that GIP occurred plentifully and caused problems on animals and farmers. *Haemonchus contortus* was the most prevalent parasite with an occurrence of 94.23% next was Strongyle infections with prevalent 93.18% of the animals examined. Prevalence of flukes was highest in December.

According to studies that were mentioned above it is obvious that parasitological surveys were focused only on prevalence of the GIP, or comparing GIP occurrence according to season, anima age, area, pasture and fodder.

I did not find single study focused on parasitological survey linked with socioeconomic factor which could be influence GIP prevalence in goat.

1.3.2. General overview on Coccidia

Coccidia is subclass of protozoans parasitizing in epithelial cells of the intestinal tract. They are parasites of arthropods and vertebrates causing severe disease in humans and economically important animal disease coccidiosis. Coccidia parasites can be found also in the liver and rarely in other organs. This subclass comprises three orders: Eimeriida, Eucoccidiida and Lankesterellidae (Right diagnostic, 2012)

1.3.3. General overview on Helminths (Worms)

Helminths belong to four Phyla: Nemathelminthes, Plathelminthes, Acanthocephala and Annelida. The most important classes of helminths are Nematoda, Cestoda and Trematoda (Reinecke, 1983). Helminths taxology is not uniform but have many forms (Jurášek *et al.*, 1993). *"The most common parasitic helminthes belong to three classes of invertebrates, the cestodes or tapeworms, the trematodes or flukes and the nematodes or roundworms"* (WHO, 2004). The individual attribute of each class are described in Table 4 and in classification Figure 5.

Table 4: General attributes of Helminths (WHO, 2004)

FEATURES	CESTODES	TREMATODES	NEMATODES
SHAPE	Flat, tape or ribbon-like and segmented	Flat, leaf-like and unsegmented	Cylindrical and unsegmented
ANTERIOR END	Has suckers and often hooks. No mouth is present	Have suckers. A mouth is present	No suckers or hooks, a mouth is present
BODY CAVITY	Absent	Absent	Present
INTESTINE	Absent	Present but no anus	Present with anus
SEXES	Hermaphrodite	Hermaphrodite except *Schistosoma spp.*	Separate male and female worms

CLASS

(A) CESTODA (Tape Worms)
- Segmented
- Possess scolex, neck and proglottids
- Hermaphroditic
- Reproduction:
  - Oviparous
  - Sometimes multiplication within larval forms
- Infection generally by encysted larvae

(B) TREMATODA (Flukes)
- Unsegmented
- Leaf like or cylindrical
- Generally hermaphroditic
- Reproduction (digenetic):
  - Oviparous
  - Multiplication within larval forms
- Infection mainly by larval stages entering intestinal tract, sometimes through skin

CLASS

NEMATODA (Round Worms)
- Unsegmented
- Possess mouth, oesophagus and anus
- In general sexes separate
- Reproduction:
  - Oviparous
  - Larviparous
- Infection by:
  - Ingestion of eggs or
  - Penetration of larvae through skin or
  - Arthropod vector or
  - Ingestion of encysted larvae.

Figure 5: Initial classification of worms (WHO, 2004)

Following 3 chapters are focused on Cestoda, Nematoda and Trematoda that are investigated parasites in this thesis.

1.3.3.1. General overview on Nematoda

Nematodes known as worms as well, are unsegmented, hair like, tubular worms in ranging interval size from a few millimeters to several centimeters. „*Nematodes are a group of worms, which are responsible for most of the helminth diseases of veterinary importance, and tissues or organs of every class of vertebrates and even some invertebrates are vulnerable to invasion by them*"(Brander et al., 1991).

The nematode parasites consist of a large variety of species and in order to simplify this paper they are organized in four main groups based in principle on their location the hos: lungworms, gastro-intestinal worm, filaroids, miscellaneous nematodes. Gastro-intestinal worm occurred in goats are: trichostrongyloids (are found in too dry climate), ostertagia species (not to common because of the fact that most species prefer a temperate climate), strongylids, trichuris (Over, 1992).

1.3.3.2. General overview on Cestoda (tapeworm)

Every type of all cestodes has two-host lifecycles, where small ruminants (goats and sheep) can be acted as either final or intermediate hosts, depending on parasite species (Urquhart et al., 1996). The adult worms are found in the small intestine of goats or sheep. Proglottids and eggs are passed out in the faeces of the infected animal. In the environment, the eggs may be ingested by oribatid mites where they develop into cysticercoids. The cysticercoids that are the infective forms are produced from 1 to 4 months period depending on temperature. Ruminants are infected by the ingestion of the infected mites with herbage. The prevalent period is 5 to 6 weeks (Kusiluka and Kambarage, 1996).

1.3.3.3. General overview on Trematoda (Fluke)

Trematoda belong to the phylum Plathelminthes (flatworms), class Trematoda and subclass Digenea. The adults are endoparasitic causative agents of well known pathology in domesticated animals. A range of digenetic trematodes inhabit the lumen of the digestive tract. These luminal infections cause morbidity and diseases of relatively mild nature unless present in this location in excessive numbers (Kumar, 1999).

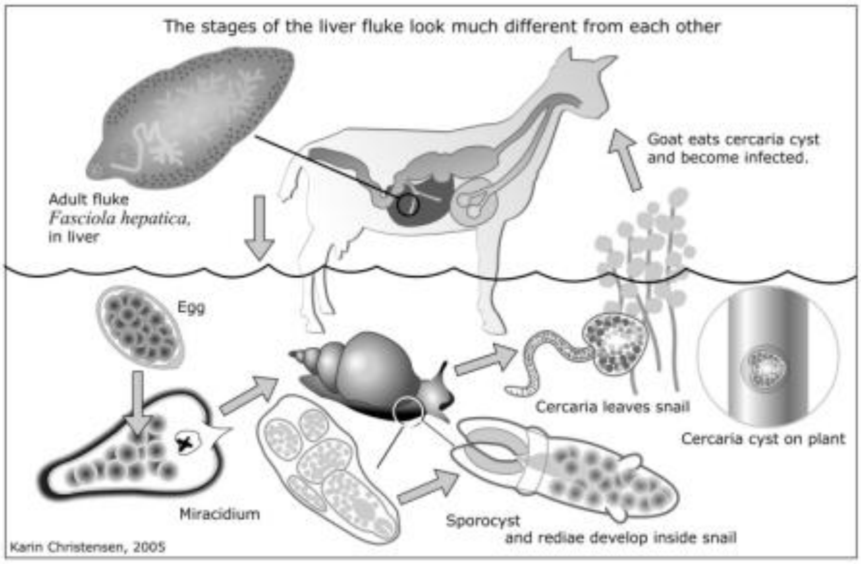


Figure 6: Animation of the life cycle of *Fasciola hepatica*

1.3.4. Description of helminths recognized in Angola

On this topic scientific literature do not provide any relevant study focused on goat helminthiasis in Angola. Unique found information was article of Rosa *et* al., (2008) where describe literature history about surveys focused on goat´s helminths parasite realized in Angola. He point out that Dias (1950) writes the first list of parasites of domestic animals in Angola, where refers to the presence of Protozoa, Platyhelminthes, Nematoda, Arthropoda (Insecta and Arachnida). In the following decades, studies on the parasitological fauna and its impact on animal production and health were developed by several researchers, which emphasized the vast literature left by Fernando Serrano, Victor Caeiro, Travassos Dias (1950) and Jaime. However, the discontinuity of the studies by known reasons (Civil war) makes the information unavailable and not left and/or easily accessible.

Unique relevant survey that could be useful for this thesis is the research published by Gomes (2001) studying Helminths affecting grey duiker (*Sylvicapra grimmia*) in Angola. Gomes (2001) applied his survey in 1990 – 1992 in central part of Angola in different provinces as Benguela, Bié, Huambo, Huíla. Gomes analyzed 14 different faeces samples, the helminths search was performed as Euzeby (1982) described, for small ruminants. The collected helminths were preserved in formalin and then identified microscopically after clarification with lacto phenol. The identification was made based on Soulsby (1982), Gibbons (1979, 1981), Boomker (1977), Cruz e Silva (1971), Yeh (1959), Verster (1969) and Wardle & McLeod (1952). His results are showed in the table below.

Table 5: Helminths identified in common duiker in Angola (Gomes, 2001)

Espécie de helminta	Número de animais parasitados	Intensidade média
Trematoda		
Paramphistomum spp.	3	8
Cestoda		
Moniezia expansa	2	1
Avitellina centripunctata	1	2
Stilesia hepatica	2	*
Taenia hydatigena (forma larvar)	2	2
Taenia sp. (forma larvar)	1	1
Nematoda		
Trichostrongylus colubriformis	1	3
Trichostrongylus axei	3	42
Cooperia pectinata	1	21
Cooperia hungi	2	17
Haemonchus contortus	4	23
Haemonchus vegliai	3	8
Impalaia tuberculata	3	26
Trichuris sp.	2	17
Setaria hornbyi	6	1
Setaria caelum	2	1

Others accessible helminth surveys realized in Angola were focused on intestinal parasitic infections in school-going children done by Tomlinson et al. (2010), on Towards an Atlas of Human Helminth Infection in sub-Saharan Africa carried by

Brooker et al. (2010), Hotez et al. (2009). Because of different final host (human instead of goat), these studies are not relevant for this survey.

1.4. Socioeconomic studies in SSA

There were written many studies about SSA that were based on questionnaire surveys, focus groups, personal interviews, etc. Those studies come from different part of SSA with different topic and mainly are focused on agriculture (see Williamson *et* al., 2008, Snapp et al., 2002), household socioeconomic situation (see Ismael et al., 2002), healthy situation (see Caldwell et al., 2006, Hargreaves et al., 2007). This questionnaire method is mainly used in SSA, there practically do not exist other relevant sources of information, exemplary country is Angola. Mentioned surveys were mainly based on questionnaires and personal interviews. Important role plays cooperation with local authorities that is very helpful and indispensable. Nevertheless by using this methods big risk could also occurs – the credibility of the data. Field work with local people in SSA especially in Angola is very hard and implementer should first build trust between him and local agricultures. Sometimes local people do not understand given questions and rather answer always yes to satisfy the implementer. Sometimes they do not want tell the true. It is very important in using these survey methods to build and strengthen the relationship. Firstly implementers have to know the area, local people, their culture, spend more time with them. After acclimatization in local area and getting to know local people it is possible try to collect some data by using questionnaires or personal interviews. Majority of these studies (mainly focused on agriculture surveys) do not mentioned complications that occurred with using these methods.

There are several studies that exanimate credibility of collected data in SSA by using those methods. Sobngwi et al. (2001) designed the Sub-Saharan Africa Activity Questionnaire (SSAAQ) that was based upon existing questionnaires in Cameroon. Result shows that the questionnaire was highly reproducible ($p = 0.95$; $p < 0.001$) and the interview difference did not differ significantly from 0. Other study from Lengeler et al. (2002) shows a relationship between the questionnaires and the parasitological data which revealed a striking correlation. The proportion of positive responses to the two key questions certify significant positive associations with the prevalence of *S. haematobium* (for both questions: $r = 0.90$, $p < 0.0001$).

2. Goals

Aim of the study is to search gastrointestinal parasites situation of goats breed in several villages in the municipal Catabola (province Bié, Angola) and to test the possible influence of socioeconomic correlates.

The specific objectives of the survey:

1. to analyze the level of gastrointestinal parasites of goat in municipal Catabola
2. testing the influence of other correlated socioeconomic parameters
3. description of the socioeconomic characteristics of communities including goat keepers in municipal Catabola
4. comparison parasite prevalence in different species of livestock bred by goat´s keepers
5. to make recommendations regarding the use and development of goat breeding in order to balance development needs, address poverty and ensure sustainability.

Hypothesis:

- Number of goats depends on size of villages, literacy of farmers and number of goats keepers
- Dependence of parasite prevalence according to literacy rate, age, sex of farmers and different kind of source of water will influence parasite prevalence.
- Rate of goat’s mortality will rise with increasing overall parasite prevalence or particular parasite species.
- There is some correlation between the parasite prevalence in different species of livestock.
- The level of parasite prevalence will be influenced by same of socioeconomic variables (source of energy, source of water, keeper´s age, sex and rate of literacy, wealth, size of village)

3. Methodology

In this study have been used two types of survey – parasitological and socioeconomic survey. Parasitological survey consisted of faeces sample collected from goat flock. Socioeconomic survey was based on questionnaire surveys and personal interviews with representatives of villages and goat keepers. Both studies were conducted in the same areas.

3.1. Study area

The study was carried out in Angola in the Bié Province, in municipality Catabola, which is located 75 km southeast of Kuito (capital city of Bié Province). The municipality lies between latitude 12° 9' 0" S/17° 17' 0" E. The average annual temperature ranges from 18 °C and 20 °C, the atmosphere may be considered as warm temperate. The annual average temperatures maximum ranges from 25°C and 27°C, and the average minimum temperature is between 11° C and 13°C. According to the Thornthwaite classification, the entire surface is covered in humid climates (see Table 1, Figure 1). The rainy season, coinciding with the time hot, hard, on average, about seven months, is extending from October to April. There is good rainfall distribution and rainfall ranges from 1100 mm to even a little above 1400 mm. The dry season, commonly referred to mist, lasts the remaining months of the year. The annual average relative humidity variesfrom between 60% to 70%, verifying the maximum in January (75 – 80%) and minimum August (33 – 40%) (Diniz, 1973).

Goats were randomly sampled in six small villages; Calei, Nhuanguri, Nhime, Onque, Sanhuile, Ussamba and in one little town Catabola (see Figure 8). The investigations were released on September 2010 - March 2011, a period covering 6 month of the rainy season. Surveyed villages Calei, Nhuanguri, Nhime, Onque, Sanhuile, Ussamba have similar live standard and village structure. Head of village is "soba" who drives all activities in village. Houses are built from argil without energy, canalization and water in the centre of nature. Infrastructure is insufficient if there is any. There are no public services as hospital, school act. Number of habitants is between 300 up to 1500 persons per village. The most farmed livestock are poultry and goats, rarely cattle.   Compared to those, Catabola is small city with houses construction with access of public electricity (only from 18 till 23), public services as health service, schools, small shops, gas station. Number of habitants is around 90 000 persons. During rainy season is very difficult get to the smaller villages, also Catabola is not accessible because of unattended earthen road.

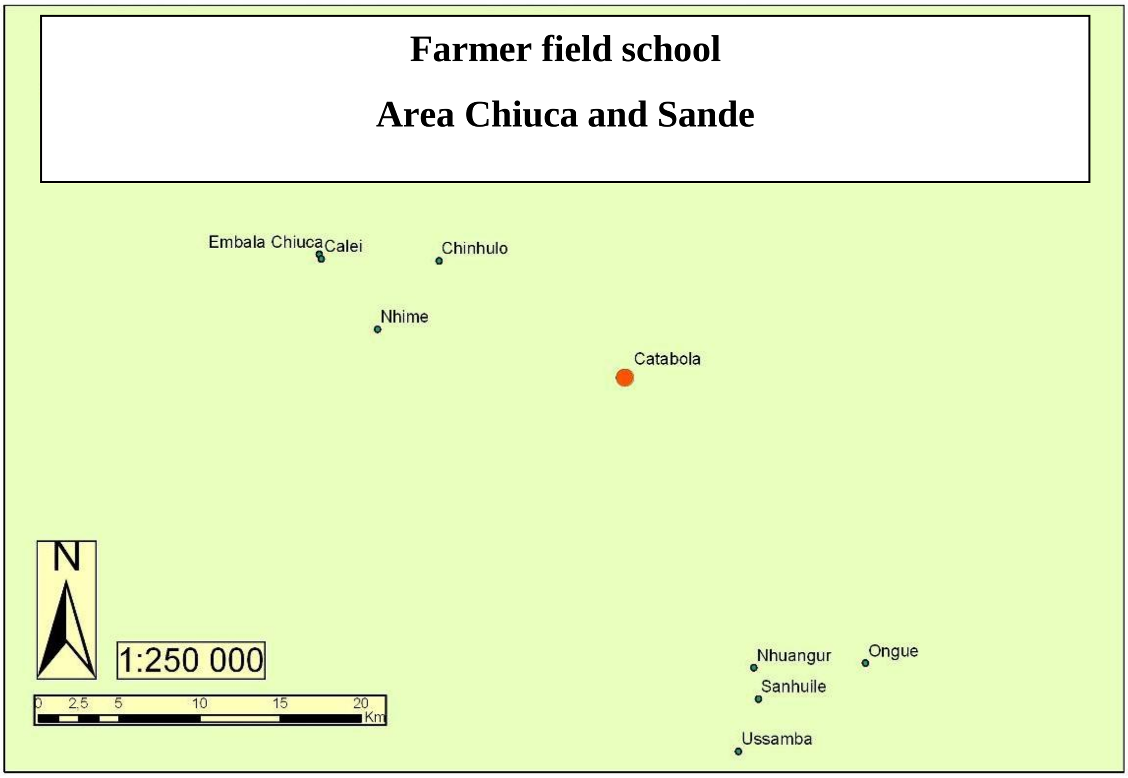


Figure 7: Farmer field school map of municipal Catabola

3.2. Parasitological survey

Studied goats

The goats sampled were mainly of the small West African breed. Goats were only females and of all ages. The origin of goats is from market in Catabola and Kuito, or local.

Faeces sample collection and analysis

A sample of 37 goats was chosen. Faeces samples were obtained directly from the rectum and each sample was then placed in a separate plastic bag, packed and the same day analyzed in the local laboratory. The following methods for coprological (which were modified) exam to identify nematodes were performed:

- Ovoscopic techniques: Willis flotation method, Sedimentation
- Larvoscopical techniques: Vajda method

Willis flotation method

This method was used for detection oocysts of coccidia, and eggs of nematodes and tapeworms. For flotation method was required solution with a specific gravity of 1.3 diluted in 1200 g of sugar in one liter of water, after was added a few drops of formalin. It was mixed 4 small pieces of feaces in 10 – 15 ml water until the porridge consistency. Solution was filtered with the sieve (size 0.25 – 0.5 mm) and poured in the beaker centrifuge during 3 minutes in an overhead of G 300 (about 3000 rotations) in medium centrifugal. The supernatant was spilled out and rested sediment was refill with mixture sugar solution. This solution was centrifugal again during 3 minutes about 3000 rotations per minute. The sample was removed from surface of solution and observed with light microscope with maximal magnification 400x .

Sedimentation

Sedimentation methods were used for detention of heavy eggs of plathelminths and Acanthocephala (Trematoda, acantocephala). Approximately 3g of faeces were mixed with water and filtered through the sieve 0.25 – 0.5 mm. Solution was fulfillment in 50 ml beaker with water and let settled about 5 minutes. The supernatant was refilled and the sediment was fulfilled with fresh water. Al process was repeated until the supernatant came pure. One drop of sediment was put on microscopic slide by Pasteur pipette and one drop of trypane blue. After that the sample was immediately observed without the cover glass with magnification 100x.

Vajda method

This examination was used to indicate L1 larvae, especially pulmonary nematodes, e.g. Dictyocaulus *spp.* The sample of 3 g feaces was put to the gauze packed and then put on the watch glass with warm water (about 40° C). After 30 – 60 minutes the feaces were removed from gauze and rested water on the watch glass was observed by magnification 40x.

Every goats sample was examined by all three methods. If the specific parasitic elements (egg, oocyst or larva) were occurred in a sample, were counted. Due to lack of equipment (ocular micrometer scale) in local parasitological laboratory and lack of experience was the identification of parasite species restricted to categories, which were determinate on based of author's possibilities to recognize eggs and larvae: The categories were following: coccidian parasites (mainly *Eimeria* spp.), trematoda (mainly *Fasciola* spp., *Dicrocoelium* spp.), *Moniezia* spp., *Strongyloides* spp., *Trichuris* spp., Strongyles and lung worms larvae.

3.3. Socioeconomic survey

Socioeconomic data were collected by using personal interviews to find out information about goats keepers and their family and by using pre-administered questionnaires to find out general information about villages.

Selection of goat's keepers and villages: Villages and goats keepers were chosen specifically. In these areas in the same time the project of CAU was running and author was working on it (Farmer field school). Due to good project background author could implement his research easily.

Personal interviews: Personal interviews were held in seven villages, totally with 37 goat's keepers and followed a pre-designed set of questions. The survey was targeted at the social and economic situation of the family - as literacy, livelihood, living standard, income (see Appendix 3).

This method was unique one to received correct and exact data because of high level of illiteracy (80%, see results) and inability of goat's keepers to understand questionnaire. Over time between author and goats keepers trust growth, this had positive impact on obtained information. Goat's keepers' did not respond only to satisfy interviewer, how they are used to do, but answered according to reality.

A self-administered questionnaire was filled in by representatives of villages in each village. This questionnaire pertained to the same localities where the personal interviews were conducted. The specific research question posed in the survey of village represents deal with socioeconomic situation of village as number of habitants, source of water and electricity, breeding of animals, public services in villages, etc.

3.4. Data analysis

Data were analyzed by using both standard and multi-variate statistics. Due to limited number of data and non normal data distribution in some variables, I used non parametric tests: Kruskal-Wallis ANOVA and Spearmann correlations. It was also used both simple linear regression and multiple regression, when tested variables have not normal distribution, they were transformed (log). After the construction of regression, I examined weather this regression fits regression predictions by using residual analyses. Additionally I used multi-variate statistics to test relationship between larger numbers of variables. To reduce the large number of variables to a smaller number of uncorrelated variables I used Principal component analysis. All statistics tests were conducted in STATISTICA Analysis System, version 10.0 (StatSoft Inc. 2012).

3.5. Limitation of the survey

Limited number of participants

The number of participated goat’s keepers was low. It should be according to the fact that many people could not take time off from their activities but could be caused by distrust of goat’s keepers in the beginning of the survey. With more frequent visits and intensive work relation, farmers cooperated more, but time of survey was limited only for six month. Other reason of low samples number was strong rainy season, in which many time was impossible field work.

Difficulty in accessing relevant data, literature and government documents

Some information of the research was drawn from literature and materials obtained from the Ministry of Agriculture of Angola and local organizations EDA. In this cases was very difficult obtain relevant data to the study. Such experiences were noted in some others authors (Cardoso, 2005). The majority of data relating with Catabola were estimated according to interviews with EDA organization staff and authors observing.

4. Results

4.1. Summary results for individual villages

Data were collected in seven villages during rainy season, average number of habitants in all studied area were 14 170 with standard deviation ± 36 114.1 Average number of habitants in six villages (without Catabola, which has much higher number of people - 96 066) was 521 habitants per village with standard deviation ± 353.5 (see Table 6).

Table 6: Population in villages

Village	Number of habitants	Number of male	Number of female	Number of kids	Number of families
Calei	139	21	31	87	34
Nhuanguri	370	52	84	234	52
Nhime	483	102	130	251	118
Onque	731	141	184	406	165
Catabola	96.066	18.520	26.026	51.520	28952
Ussamba	1.117	150	817	100	490
Sanhuile	286	52	82	152	82

In all seven villages the main source of livelihood is agriculture only few people in two villages - Onque and Ussamba are hunters, in Calei, Nhime, Ussamba and Sanhuile a few have your own business (as shop). In Catabola, Nhuanguri, Nhime, Onque and Sanhuile several habitants are employed in government services and hunters are only in Onque (see Table 7).

Table 7: Number of families which breed goats and division according to livelihood

Name of village	Number of families which kept goats	Number of families according to source of livelihood			
		Agricultures	Hunters	Businessman	Services
Calei	24	33	0	1	0
Nhuanguri	45	50	0	0	2
Nhime	45	467	0	3	1
Onque	126	165	7	0	2
Catabola	18590	11250	0	5620	1720
Ussamba	50	490	25	10	0
Sanhuile	39	82	2	1	2

All villages have your local school and children attend school. Adult literacy in six villages is up to 20% but in Catabola it is about 60%. Only Catabola have its own source of energy (see Table 8).

Table 8: School attendance, literacy, source of water and energy, village wealth

Name of village	school attendance	literacy in%	source of water	source of energy	village wealth	
					motor bike	Cars
Calei	yes	10	river	no	1	0
Nhuanguri	yes	10	well	no	14	0
Nhime	yes	10	river	no	9	0
Onque	yes	20	well	no	18	1
Catabola	yes	40	well	yes	3000	150
Ussamba	yes	10	well	no	3	0
Sanhuile	yes	20	river	no	4	0

Chicken are the most kept in villages (only in Sanhuile in first place are goats) and goats occupy second place (see Table 9).

Table 9: Numbers of livestock animals breed in villages

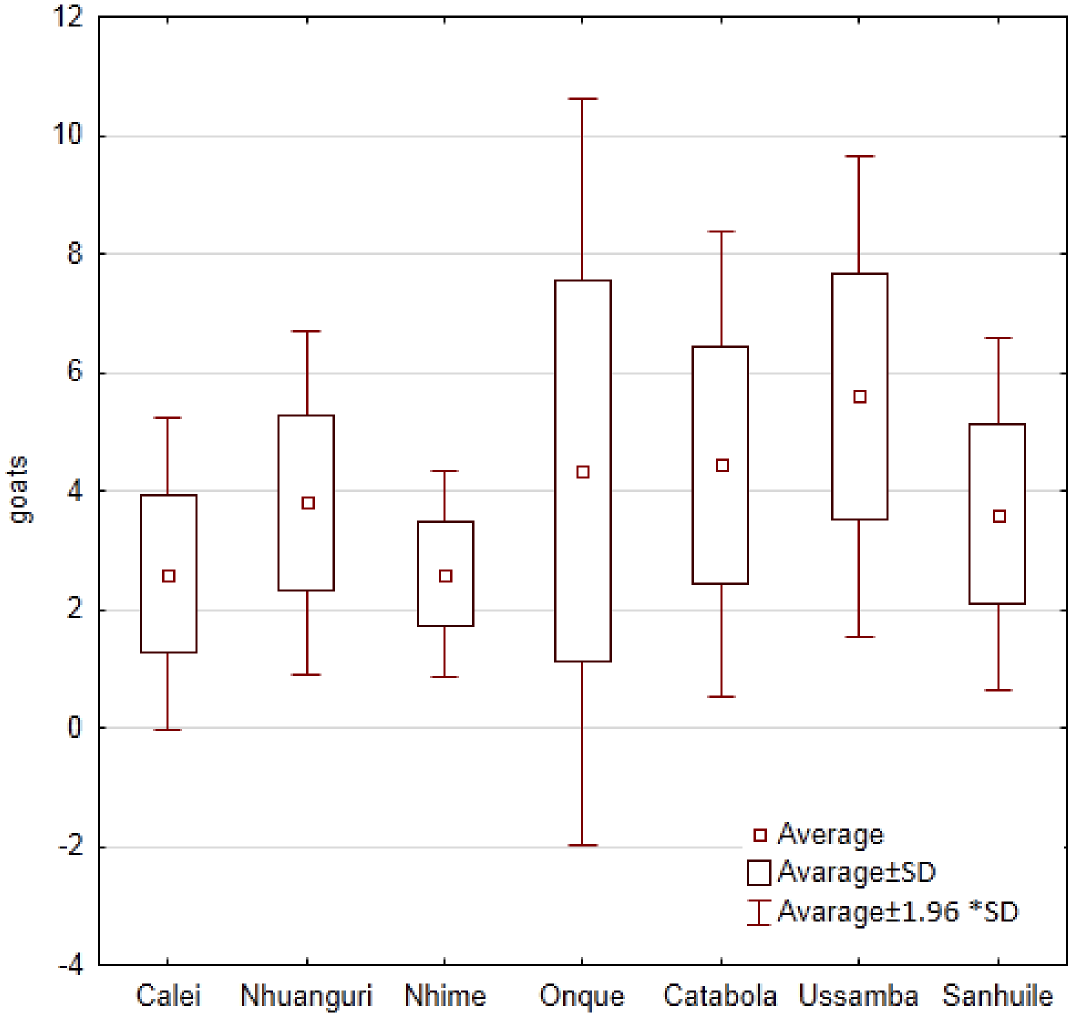
Name of village	Number of livestock animals breed in villages						
	cattle	goats	chicken	sheep	pigs	pigeon	ducks
Calei	21	64	49	0	8	0	0
Nhuanguri	0	80	100	0	8	0	0
Nhime	0	87	226	0	30	0	23
Onque	0	610	948	0	75	87	5
Catabola	250	72500	80250	0	425	0	95
Ussamba	4	200	200	0	100	0	6
Sanhuile	4	149	84	0	12	9	0

It was tested by Kruskal-Wallis test whether there is any significant difference among villages in numbers of bred livestock. The results show any significant difference however there are some trends:

Goats: Kruskal-Wallis, H (7, N= 37) = 10.3; p = 0.17; Ducks: H (7, N= 37) = 6.4; p = 0.49; pigs H (7, N= 37) = 12.9; p = 0,074; chickens H (7, N= 37) = 9.9; p = 0.19; cattle H (7, N= 37) = 3.1; p = 0.87

The number of goats breed in families did not differ among villages: Kruskal-Wallis test: H (6, N= 37) = 9.98; p = 0.13 (see Graph 1).

Graph 1: Numbers of goat breeding according to villages



During rainy seasons all goats are during day on rope and during night are in sheds. Main fodder is pasturage only in Onque and Catabola is fodder completed by other fodder supplement as rest of kitchen (see Table 10).

Table 10: Goats origin, housing, fodder

Name of village	Goats origin	housing		fodder	fodder supplement
		day	night		
Calei	local	rope	shed	pasturage	No
Nhuanguri	local	rope	shed	pasturage	No
Nhime	market in Catabola	rope	shed	pasturage	No
Onque	local	rope	shed	pasturage	Yes
Catabola	market in Catabola	rope	shed	pasturage	Yes
Ussamba	local	rope	shed	pasturage	No
Sanhuile	local	rope	shed	pasturage	No

Average total goat mortality in all studied area achieve 18 602 goats with standard deviation ± 49 121.9 to 1 village. Average total goat mortality in six smaller villages (without Catabola, which has much higher number of total goat mortality – 130 000) achieve 36 goats with standard deviation ± 30.2 per one village (see Table 11)

Table 11: Goat natality and mortality

Name of village	Goat natality	Adult goat mortality	Kids goat mortality	Total mortality
Calei	25	9	1	10
Nhuanguri	24	15	17	32
Nhime	20	34	56	90
Onque	200	8	10	18
Catabola	126.000	65.000	65.000	130.000
Ussamba	11	8	7	15
Sanhuile	49	20	30	50

Table 12 describes species and number of gastrointestinal parasites (GIS) parasites which were identified in each village and Catabola. The GIP infecting goats were, in order of predominance: Coccidian parasites (*Eimeria* spp.) with prevalence of 98.52% Strongyles with prevalence of 98.52% and *Strongyloides* spp. with the same prevalence. Trematoda were not identificated in any studied area.

Table 12: Parasites prevalence in villages

	Number of feaces simple	Plumoes Nematoda	Trematoda mainly *Fasciola* spp., *Dicrocoelium* spp.	*Strongyloides* spp.	Strongylida order	Coccidian parasites mainly Eimeria spp.	*Moniezia* spp.	*Trichuris* spp	Overall prevalence
Calei	1	0	0	10	1	18	0	0	29
	2	0	0	30	5	25	10	0	70
	3	0	0	24	7	14	0	0	45
	4	0	0	9	0	190	0	0	199
	5	0	0	95	124	25	0	0	244
Nhuanguri	6	60	0	3	37	105	0	0	205
	7	6	0	0	164	52	6	4	232
	8	0	0	0	155	102	0	0	257
	9	200	0	82	249	11	0	0	542
	10	0	0	4	29	79	0	0	112
Nhime	11	200	0	42	42	40	0	3	327
	12	3	0	0	268	161	0	0	432
	13	4	0	0	10	8	0	0	22
	14	6	0	31	97	9	0	0	143
	15	0	0	11	18	156	0	0	185
Onque	16	27	0	0	2	35	13	60	137
	17	21	0	0	0	11	8	26	66
	18	31	0	15	5	27	15	87	180
Catabola	19	0	0	0	74	8	0	0	82
	20	0	0	52	307	490	24	1	874
	21	0	0	0	0	57	0	0	57
	22	0	0	0	16	19	0	0	35
	23	0	0	24	6	89	0	0	119
	24	0	0	48	59	9	0	1	117
	25	0	0	78	90	0	0	0	168
	26	0	0	12	34	0	0	0	46
	27	0	0	123	90	0	0	0	213
Ussamba	28	0	0	0	0	120	0	0	120
	29	0	0	6	8	12	0	0	26
	30	30	0	11	168	51	0	36	296
	31	0	0	6	18	22	0	0	46
	32	0	0	68	59	75	0	1	203
Sanhuile	33	0	0	9	4	0	0	0	13
	34	0	0	16	6	18	0	0	40
	35	0	0	87	29	19	0	0	135
	36	100	0	200	150	560	0	5	1115
	37	0	0	680	820	427	0	7	1936
Total %		4,44%	0%	98,52%	98,52%	98,52%	2,22%	4,07%	13

Additionally I tested the questions related to potential of parasite prevalence both in overall parasite prevalence and in abundance of each parasites species. Prevalence of *Moniezia* spp. a *Trichuris* spp. Plumoes nematods in samples among villages were significantly diferent (Kruskal-Wallis test, $p < 0,04$) but overall parasite prevalence, *Strongyloides* spp., Strongylida order and coccidian parasites did not differ.

Total parasite prevalence H (7, N = 37) = 4.3; p = 0.75. ***Moniezia* spp. H (7, N = 37) = 18.2; p = 0,011**. **Plumoes nematods H (7, N = 37) = 17.78; p = 0,013**. ***Trichuris* spp. H (7, N = 37) = 14.57; p = 0,04**. *Strongyloides* spp. H (7, N = 37) = 10.22; p = 0,18. Strongylida order H (7, N = 37) = 11.18; p = 0,13. Coccidian parasites *sp.* H (7, N = 37) = 3.74; p = 0.81

4.2. Dependence the number of bred goats on different socio-economic factors in studied villages

Multiple regressions were performed to test the following questions:

- Do the numbers of bred goats depend on size of village (according to number of families)?
- Do the numbers of bred goats depend on the number of goat's keeper?
- Do the numbers of bred goats depend on the literacy of the villagers?
- Do the numbers of bred goats depend on the livelihood?
- Do the numbers of bred goats depend on village wealth?
- Do the numbers of bred goats depend on source of water and source of energy?
- Do the numbers of bred goats depend on their purchase origin?

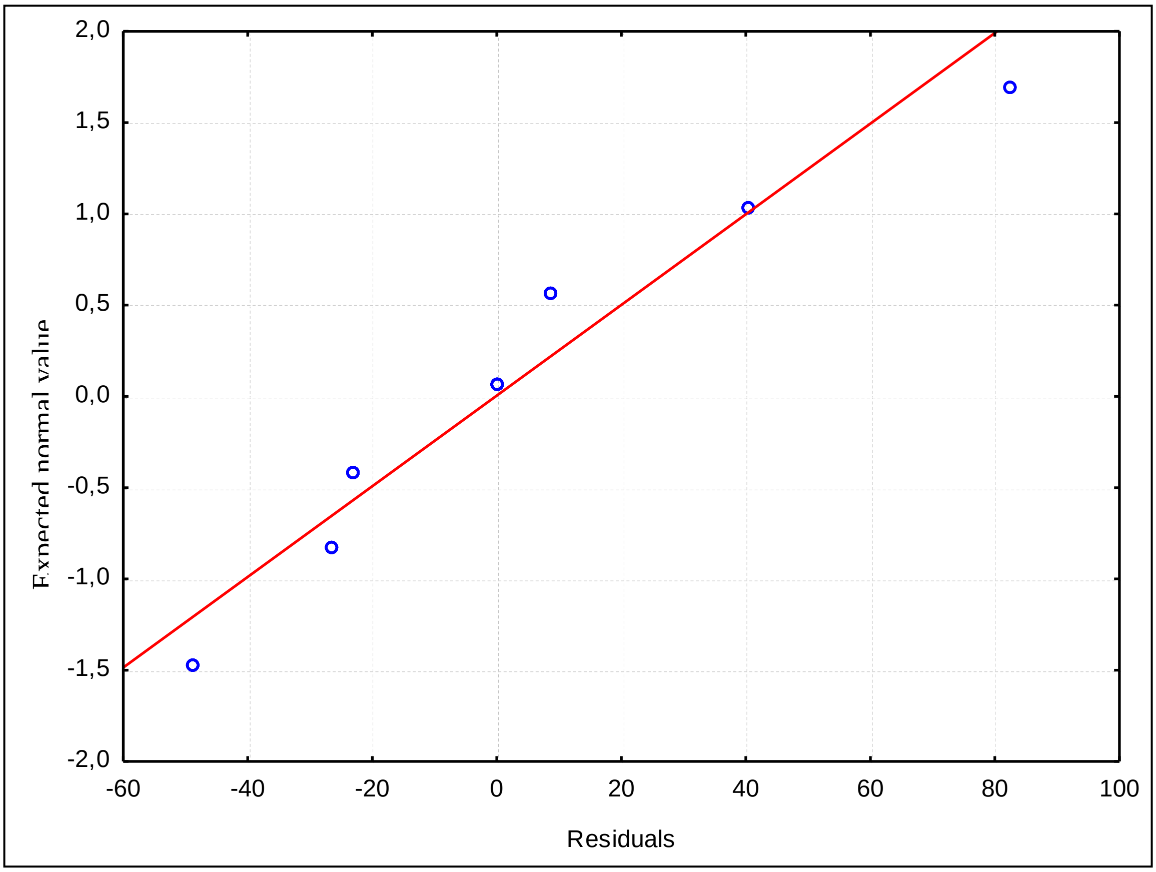
The resulting model included three following variables – size of village (according to number of families), villagers' literacy and the number of goat´s keeper. The model did not include following variables: dependency on source of water and energy, village wealth, source o livelihood of village habitants and origin of bred goats because of their low variability or not fulfillment of minimal criteria for entrance to the analyses. This model explains 99.9% variability. Partial contributions of each tested variables into resulting model based on standardized regression coefficients were following: 1. Parameter size of village ($b = 6.3$ variation; $p < 0.002$), 2. villager literacy ($b = 0.4$; $p < 0.001$) 3. number of goats keeper ($b = 93.2$; $p < 0.001$) (see Table 13).

This multiple regression reached presumptions which assume linear relationships between the variables in the resulting equation and normal distribution residuals (see Graph 1).

Table 13: The multiple regression of number goats with 3 variables (size of village, number of goat keepers, adult illiteracy)

	Partial contributions	Partial. correlations	p-value
Size of the village	0,063846	0,505365	p = 0.002
Number of goat keepers	0,931951	0,993083	p < 0.001
Literacy	0,004436	0,759827	p < 0.001

Graph 2: Normal probability Plot of Residuals



Further analyze is concerned to which extent the number of different livestock among each others. The correlations were examined by using Spearman correlation due to the lower number of collected data and not normal data distribution. Result shows high correlation between the number of goats and pigs (r = 0.95), the number of goats and chicken (r = 0.85) and the number of goats and ducks (r = 0.76). Other interesting correlation is between goats and cattle, where is middle correlation (r = 0.48). These results argue that individual livestock correlates against each others with high correlation coefficient with one exception and that is breeding of pigeons (see Table 14).

Table 14: Correlation among individual kind of livestock

	Cattle	Goats	Chicken	Pigs	Pigeons	Ducks
Cattle	1.00	0.48	0.27	0.52	-0.27	0.44
Goats	0.48	1.00	**0.85**	**0.95**	0.14	**0.78**
Chicken	0.27	**0.85**	1.00	**0.88**	-0.14	0.92
Pigs	0.52	**0.95**	**0.88**	1.00	-0.11	**0.91**
Pigeons	-0.27	0.14	-0.14	-0.11	1.00	-0.37
Ducks	0.44	0.78	**0.92**	**0.91**	-0.37	1.00

4.4. Parasite prevalence and their dependence on different variables

Multiple regressions were performed to test the following questions:

4.4.1. Parasite prevalence vs. goat keeper's variables

- Does the rate of total number of parasites depend on the age, sex and literacy of goat keeper?
- Does the rate of total number of parasites depend on the source of water?

The resulting model of multiple regression included four variables (goat's keeper age, sex and literacy, source of water). This model explains 31.7 % of total variation. The partial contributions of tested variables are:

- Goat´s keeper age 8.6% variability
- Sex of goat keeper 0.9% variability
- Literacy of goats keeper 14.6% variability
- Source of water 7.6% variability

4.4.2. Parasite prevalence in goats vs. the presence of other livestock

- Does the rate of parasites depend on other bred livestock as cattle, chicken, pigeons, ducks and pigs?

The resulting multiple model about overall parasite prevalence included four variables (number of cattle, chicken, pigeons, ducks and pigs). This model explains only 9.5 % variability.

The same four variables were tested in particular species of analyzed parasites. For Plumoes nematode explained 17.4%, for Strongylida order 7.1%, for *Strongyloides* spp. 10.8%, for Coccidian parasites 4.7%, for *Moniezia* spp. 34.2% ($p < 0.02$), for *Trichuris* spp. 74.5% ($p < 0.001$).

4.4.3. Overall parasite prevalence in goats and its dependence on goat mortality

Multiple regressions were performed to test if the rate of parasites prevalence of particular species (*Moniezia* spp., *Trichuris* spp., *Strongyloides* spp., Strongylida order, coccidian parasites has influence to total mortality goats. The model explains only 9.8% variability. Overall parasite prevalence (0.7%) and Plumoes nematods (4.9%) were analyzed by simple regression.

4.5. Principal Components and Classification Analysis (PCCA)

In the following analyzes I used multivariate statistics to test interactions among number of measured independent variables. To reduce number of these independent variables I used Principal components analysis (PCA) which creates new variables using linear combinations of original ones. A new set of components, factor axes, are obtained in a lower dimensional space onto which the original space of variables can be projected (StatSoft Inc. 2012).

I tested number of PCA models to test different combinations of parameters, most of them explained less variability (up to 30%) probably due to limited number of data. The most explaining model tested both overall parasite prevalence and prevalence of individual parasites categories (Plumoes nematods, *Moniezia* spp., *Trichuris* spp., *Strongyloides* spp., Strongylida order, coccidian parasites) were influenced by combination of following independent variables related to village characters: Literacy, source of energy and water, species of livestock (cattle, chicken, duck, goats, pigeon) goat origin, natality of goats, mortality of goats.

The resulting model includes four PCA factors with eigenvalue > 1 that explain 86 % of overall variation (see Table 15). The factor corresponding to the largest eigenvalue (9.3) accounts for 48.7% of the total variance. The second one (3.5 eigenvalue) accounts 18.3%. This analyze is based on the correlation matrix. Correlation of the respective variables with each PCA factors displaces Table 16. The most correlation with PCA1 were found in the following parameters: total goats mortality ($r = 0.99$) and natality ($r = 0.99$) and individual number of livestock. The most correlation with PC2 is number of parasites.

Table 15: Eienvalues of correlation matrix and associated statistics

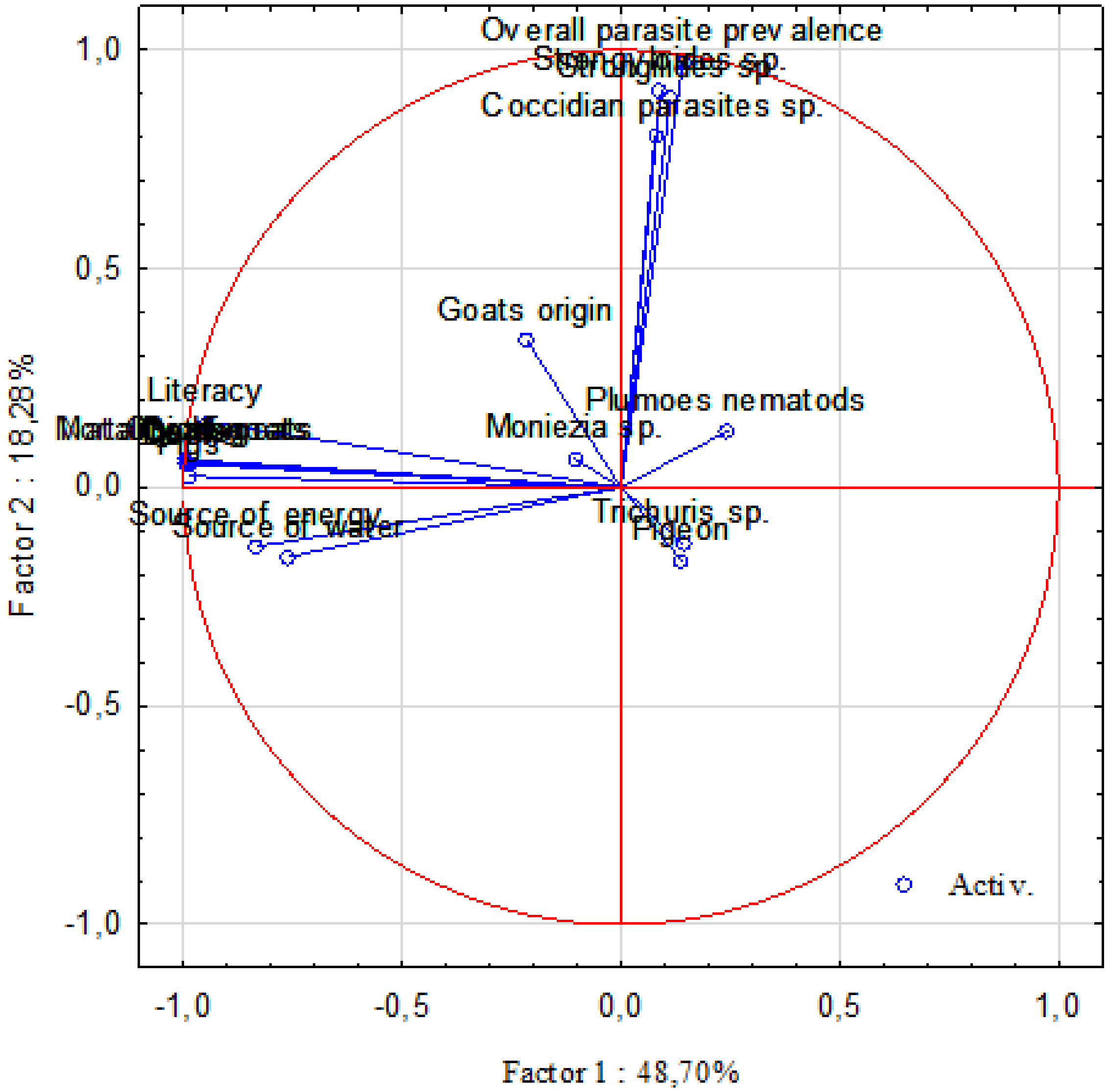
	number	% total	Cummulativ.	Cummulativ.
1	9.25	48.70	9.25	48.70
2	3.47	18.28	12.72	66.97
3	2.55	13.41	15.27	80.38
4	1.07	5.65	16.35	86.03
5	0.94	4.96	17.29	91.00
6	0.73	3.83	18.02	94.82
7	0.33	1.71	18.34	96.53
8	0.26	1.36	18.60	97.89
9	0.18	0.96	18.78	98.85
10	0.15	0.79	18.93	99.64
11	0.05	0.28	18.98	99.92
12	0.01	0.08	19.00	100.00
13	0.00	0.00	19.00	100.00

Table 16: Factor coordinates of variables according to the correlations

	Factor 1	Factor 2	Factor 3	Factor 4
Overall parasite prevalence	0,14	0,97	-0,12	-0,13
Trichuris spp.	0,14	-0,13	-0,91	0,04
Moniezia spp.	-0,10	0,07	-0,78	-0,17
Coccidian parasites spp.	0,08	0,80	-0,11	-0,05
Strongyloides spp.	0,09	0,91	-0,03	-0,13
Strongyle type	0,11	0,89	0,00	0,03
Plumoes nematods	0,24	0,13	-0,07	-0,48
Natality of goats	-1,00	0,06	0,05	-0,02
Mortality of goats	-1,00	0,06	0,05	-0,02
Goats origin	-0,22	0,34	-0,15	0,78
Ducks	-0,98	0,05	0,06	0,05
Pigeon	0,14	-0,17	-0,91	0,10
Pigs	-0,99	0,03	-0,02	0,05
Chicken	-1,00	0,06	0,05	-0,01
Goats	-1,00	0,06	0,05	-0,01
Cattle	-0,99	0,06	0,07	-0,03
Source of energy	-0,83	-0,13	-0,04	-0,36
Source of water	-0,76	-0,16	-0,45	-0,13
Literacy	-0,94	0,15	-0,13	0,12

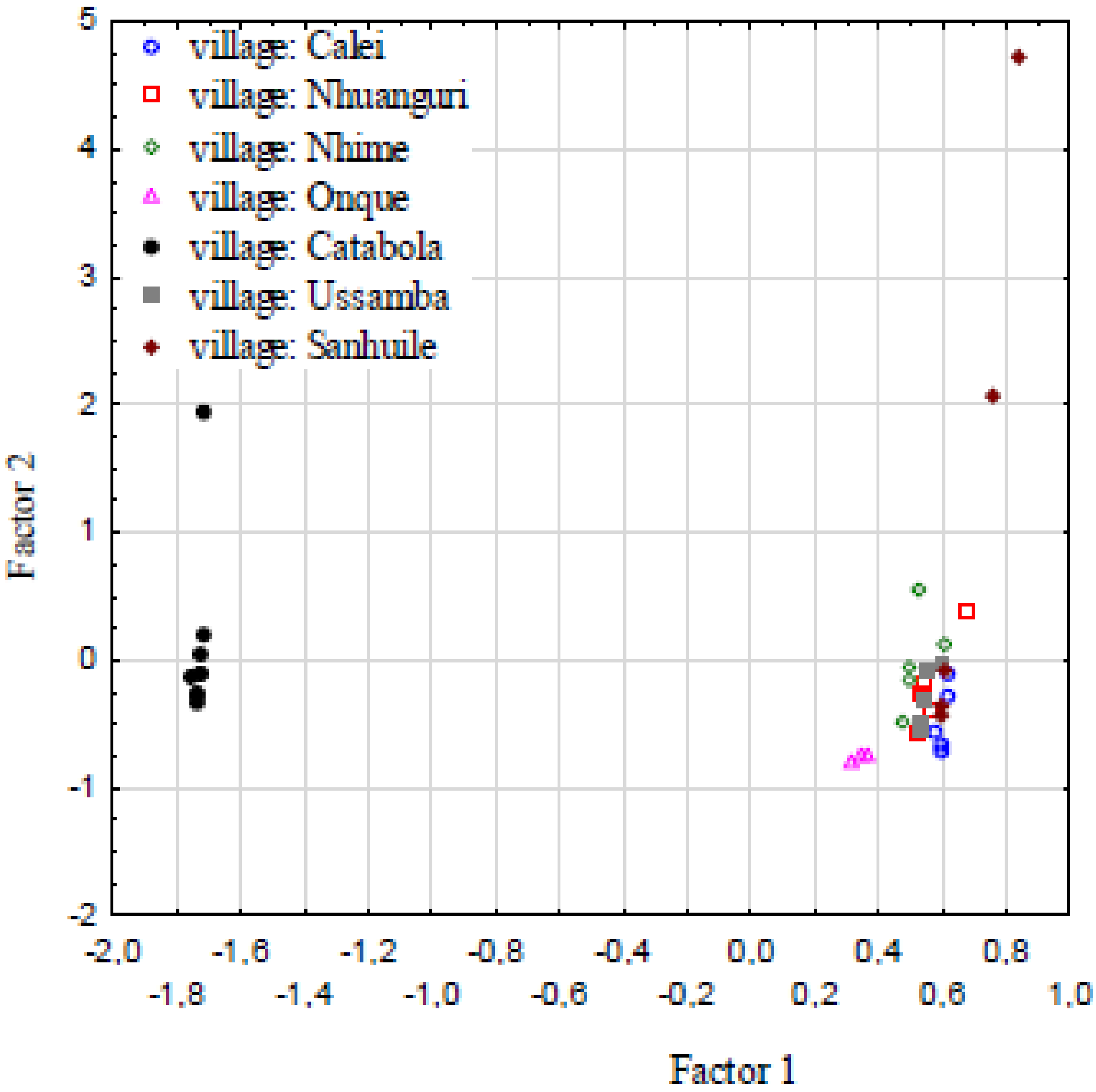
Interactions among the tested variables in the space of two first PCA axes shows graph A. Mortality, natality, source of energy and water, illiteracy mostly correlated with PCA1 that explains 48.7% of variations. Likewise it was the case with number of goats, ducks, pigeons, chickens, cattle. Overall parasite prevalence and prevalence of coccidian parasites, Strongylida order, *Strongyloides* spp. correlated with axes Y, explaining 18,3 %. Less correlation with this axes was found in goat origin. Correlations of Plumoes nematods, *Moniezia* spp., *Trichuris* sp. and number of bred pigeons showed the least correlation (see Graph 3).

Graph 3: Projection of variables into the space of the first two PCA axes



Catabola is different from the others villages based on model parameters (see Graph 4).

Graph 4: Scatter graph of Factor 2 against Factor 1, categorized by Area



5. Discussion

The study included two types of survey – parasitological and socioeconomic survey to test potential interactions. The study was carried out in Angola in the Bié Province, in municipal Catabola. More than 60 years there are no relevant study focused on goat helminthiasis in Angola and the impact on animal production and health. Such situations are alarming because rural farmers are highly dependent on goat's benefits. This domestic species represents key livestock because it is the most abundant animal in comparison to other ones. It is the result of post war situations.

Parasitological survey was based on faeces sample collecting of goat flocks. Socioeconomic survey included questionnaires and personal interviews with representatives of villages and goat keepers.

In the parasitological study were found following gastrointestinal parasites: Plumoes nematode, *Strongyloides* spp. and Strongylida order, *Momezia* spp., *Trichuris* spp. and coccidian parasite. The presence of fluks (Trematoda) was also tested but not identified. In the present study the gastrointestinal parasite prevalence followed the well-known pattern small ruminants parasites which occur in Sub-Saharan Africa. They are Helminths as Plumoes nematoda, *Strongyloides* spp. and Strongyles (Kumba et al., 2003), *Moniezia* spp. and gastrointestinal parasites Coccidia (Agyei et al., 2004). Some study (e.g. Njeruh et al., 2004) mentioned that flukes prevalence in Sub-Saharan Africa is common. On the other side very similar study conducted by Kumsa and Abebe (2008) in Etiopia also did not detect presence of Trematoda. Absence of infection with any trematode in municipal Catabola could suggest that the intermediate hosts of these parasites were not present on studied area at least during the research period.

Parasite prevalence of individual species in municipal Catabola was predominant in *Strongyloides* spp., Strongylida order and coccidia with prevalence 98.52% for each. Others gastrointestinal parasites as Plumoes nematode, *Trichuris* spp. and *Momezia* spp. occurred in prevalence 4.44%, 2.22 % and 4.07%. Those results are similar as some studies from Sub-Saharan Africa. In Senegal coccidia affected 85% studied goats (Vercruysse, 1982), in Zimbabwe, were infected on average 89.9% sampled goats (Chhabara and Pandey, 1991), in Kenya (Kanayari, 1993), Nigeria (Howe, 1984) and Tanzania (Kusiluka et al., 1996) and in South Africa were detected coccidia with a prevalence 96.6% (Harper and Penzhorn, 1999). Other survey from Etiopia (Kumsa and Abebe, 2008) presents prevalence of gastrointestinal parasites. The coproscopic examination showed an overall prevalence of 100% - Strongyle nematodes, 97.5% - *Eimeria* spp., 10.5% - *Moniezia* spp., 6.5% - Trichuris spp. and 4% for *Strongyloides* spp. In this study from Etiopia were found absence of infection with any Trematoda.

The socioeconomic study shows that size of village, villagers' rate of literacy and number of goat's keepers was found to have significant influence to number of goats. This result fulfill hypothesis which predicate that rate of literacy and more populated villages increase number of bred goats. Other point of view was to find out relationship among those variables and overall parasite prevalence. Literacy of goat keepers', sex and age of keepers and source of water had not more important influence. This result did not confirm the prediction that higher literacy rate, age and sex of farmers and source of water will influence the parasite prevalence in goats. The absence of more significant influence of age, sex, literacy on parasite prevalence could be the result of the possibility that more members of the family share care on goats not only keeper that was object of the questionnaire. The prediction that source of water included well and river could reflect the fact that animals drinking from the river could tend to be more probably infected (e.g. fluks) than those drinking water from wells. This prediction was not confirmed.

In literature does not exist available study from Sub-Saharan Africa about influence of socioeconomic factors to parasite prevalence. There are some studies focused on goat's attributes and environmental condition as variables which can influence parasite prevalence. Magona and Musisi (2004) assessed influence of grazing system, season and agro climatic zone and found a significant influence on the intensity of Gastrointestinal nematodes infections in goats, but age of animals did not. Other study form Kumba et al. (2003) compared gastrointestinal parasite prevalence in Namibia according to season and temperatures.

Farmers which bred more number of goats bred also more pigs, chicken and ducks. Additionally I tested wheatear parasite prevalence of goats is influenced by keeping other livestock. The multiple regression models showed a significant influence especially in pigs and also in chicken and pigeons on prevalence of *Trichuris* spp. This finding could indicate *Trichuris* spp. Transmission among livestock, but it is not possible because of the most of *Trichuris* species are host-specific parasites.

Overall prevalence but also particular parasites species were not found to have significant influence with high variability explanation on mortality of goats. I assumed that higher parasite prevalence will increase goat mortality but I did not record a direct link between overall parasite prevalence and mortality rate of goats. There could be large number of other factors e.g. limited duration of the study, the way of data collecting on animal mortality (questionnaires). Faye et al., (2003) mentioned other factors as bad goat management, goat age and insufficient goat´s nutrition. He focused study on different levels of diet (basal or basal diet plus supplement) was used to assess the effect of helminth infections. Other study from Fritsche et al., (1993) detected that higher worm burdens were recovered from adult and old animals. It can be other reason that hypothesis did not confirm, because my survey did not identify goat age.

In the end I tested potential interactions among more independent variables using multivariate statistics (Principal Component Analyses). I tested the interactions of the prevalence in all studied parasites on mortality and natality of goats, goat origin, source of water and energy, keeper´s literacy and breeding of other livestock. The resulting model of PCA revealed that prevalence of coccidian parasites, *Strongyloides* spp., and order Stongylida are highly positively correlated in comparison to Plumoes nematodes, *Moniezia* spp., *Trichuris* spp. With higher literacy of keepers was highly correlated with keeping of other livestock. They have also source of energy and water and higher level of natality and mortality rate in goats this probably reflects higher number of bred goats. Following canonical analyses showed that Catabola was the most distinct village from other ones based on model parameters of PCA model.

This study presents the first more detailed research on gastrointestinal goats parasites in Angola over sixties years. However, the number of data is limited due to many complications which are common in majority research in Angola this work brinks original data from this area of Sub-Saharan Africa.

6. Conclusion

- This work is focused on the research of prevalence GIP in goats kept in rural areas of Angola
- Research of socioeconomic factors of goats keepers and villages
- Testing of potential influence of some socioeconomic factors to parasite prevalence in goats and other factors e.g. presence of other livestock, mortality and natality rate in goats.
- Detecting following gastrointestinal parasites: coccidian parasites (mainly *Eimeria* spp.), trematoda (mainly *Fasciola* spp., *Dicrocoelium* spp), *Moniezia* spp., *Strongyloides* spp., *Trichuris* spp., nematodes of the order Strongylida and lung worms larvae
- The socioeconomic study shows that size of village, villagers' rate of literacy and number of goat's keepers was found to have significant influence to number of goats.
- Literacy of goat keepers', sex and age of keepers and source of water had not more important influence on parasite prevalence
- Farmers which bred more number of goats bred also more pigs, chicken and ducks.
- Significant influence especially in pigs and also in chicken and pigeons on prevalence of *Trichuris* spp.
- Overall prevalence but also particular parasites species were not found to have significant influence with high variability explanation on mortality of goats.
- The resulting model of PCA revealed that prevalence of coccidian parasites, *Strongyloides* spp., and order Stongylida are highly positively correlated in comparison to Plumoes nematodes, *Momesia* spp., *Trichuris* spp. With higher literacy of keepers was highly correlated with keeping of other livestock. They have also source of energy and water and higher level of natality and mortality rate in goats this probably reflects higher number of bred goats.

7. References

Agyei, A., D., Odonkor, M., Osei-Somuah, A. 2004. Concurrence of Eimeria and helminth parasitic infections in West African Dwarf kids in Ghana. Small Ruminant Research 51: 29 – 35.

Ashley, S., Holden, S., Bazeley, P., 1999. Livestock In Development. Livestock in Poverty-Focused Development. Crewkerne: Livestock in development. ISBN 0 9528061 2 6

Ayele, Z., Peacock, C., 2003. Improving access to and consumption of animal-source foods in rural households: the experiences of women-focused goat development program in the highlands of Ethiopia. In: Animal Source Foods to Improve Micronutrient Nutrition and human function in Developing Countries, Supplement to the Journal of Nutrition.

Azis, M., A., 2010. Present status of the world goat population and their productivity. Small Ruminant Research 45: 42 – 56.

Baker, R., L., Audho, J., O., Aduda, E., O., 2001. Genetic resestance to gastro-intestinal nematode parasites in Galla and Small East African goats in the sub-humid tropics. Animal Science 73: 61 – 70.

Bester, J., Ramsay, K., A., and Scholtz, M., M., 2009. Goat farming in South Africa: Findings of a national livestock survey. Applied Animal Husbandry & Rural Development 2: 9 – 13.

Boyazoglu, J., Hatziminaoglou, I., Morand-Fehr, B., 2005. The role of the goat in society: Past, present and perspectives for the future. Small Ruminant Research 60: 13 – 23.

Brander, G., C., Pugh, D., M., Bywater, R., J., 1991. Veterinary Applied Pharmacology and Therapeutics. 5th Ed. Bailliere Tindall: 513 – 548.

Brito, G., J., 1947. ex: Gray G., O., Woolaston R., R., Caldwell, B., T., Eaton, J., C. Breeding for Resistance to Infectious Diseases in Small Ruminants. ACIAR, Camberra. ISBN 1863201416

Caldwell, P., Quiggin, P. 1989. The Social Context of AIDS in Sub-Saharan Africa. Population and Development Review 15: 185 – 234.

Cardoso, P., Sowman, M., Duart, A. 2006. Socio-economic baseline survey of coastal communities in the BCLME region – Angola. Final Report. BCLME PROJECT LMR/AFSE/03/01/C

Chartier, CH., Paraud C., 2011. Coccidiosis due to Eimeria in sheep and goats, a review. Small Ruminant Research. (in press).

Chhabara, R., C., Pandey, V., S., 1991. Coccidia of goats in Zimbabwe. Vet. Parasitol. 39: 199 – 205.

Diniz, A., C., 1998. Angola: O Meio Físico e Potencialidades Agrárias. Instituto da Cooperação Portuguesa, Sintra, Portugal.

Ehui, S., Benin, S., Williams, T., Meijer, S., 2002. Food Security in Sub-Saharan Africa to 2020, Socio-economic and Policy Research Working Paper 49, International Livestock Research Institute, Nairobi.

Fabiyi, J. P. 1987. Production losses and control of helminths in ruminants of tropic. International Journal for Parasitology 17: 435 – 442.

FAO, 1992. Distribution and impact of helminth diseases of livestock in developing countries. FAO Animal Production and Health paper, 96. FAO, Rome: 221

FAO, 1997. Agricultural Yearbook. Food & Agricultural Organization of United Nation, Rome, Italy.

Faye, D., Leak, S., Noual, S., Fall, A., Losson, B., Geerts, S. 2003. Effect of gastrointestinal helminth infections and plae of nutrition on the health and productivity of F1 (West African Dwarf x Sahelian) goat crosses in The Gambia. Small Ruminant Research 50: 153 – 161.

Fritsche, T., Kaufman, J., Pfister, K., 1993. Parasite spectrum and seasonal epidemiology of gastrointestinal nematodes of small ruminants in The Gambia. Veterinary Parasitology 2-4: 271 – 283.

Gethiko, A., K., Lindsay, S., W., Confalonieri, U., E., 2000. Climate change and vector-borne diseases: a regional analysis. Bulletin of the World Health Organization 78: 9.

Gomes, A., 2001. Helmintas parasitas do Bambi comum (*Sylvicapra grimmia*) em Angola. RPCV Revista Portuguesa de Ciencias Veterinárias: 75 – 85.

Graber, M., 1975. Helminths and Helminthosis of different domestic and Wild Animals of Ethiopia. Bull. Anim. Hlth. Prod. Afr. 23: 57 – 86.

Harper, C., K., Penzhorn, B., L., 1999. Occurrence and diversity of coccidia in indigenous, Saanen and crossbred goats in South Africa. Vet. Parasitol. 82: 1–9.

Howe, P., A., 1984. Diseases of goats. The T.G. Hungerford Vade Mecum Series for Domestic Animals 5: 62.

IEMVT, 1980. Les petits ruminants d'Afrique Centrale et d'Afrique de l'Ouest. Synthese des connaissances actuelles: 295.

Ismael, Y., Bennett, R., Morse, S. 2002. Benefits from Br Cotton Use by Smallholder Farmers in South Africa. AgBioForum, 5: 1 – 5.

Jurášek, V., Dubinský, P., 1993. Veterinárna parazitológia. Bratislava, Priroda. ISBN 80-07-00603-6.

Kanani, J., Lukefahr, S. D., Stanko, R. L. 2006. Evaluation of tropical forage legumes (Medicago sativa, Dolichos lablab, Leucaena leucocephala and Desmanthus bicornutus) for growing goats. Small Ruminant Research 65: 1 – 7.

Kanayari, P., W., N., 1993. The relationship of between coccidial and helminth infections in sheep and goats in Kenya. Vet. Parasitol. 51: 137 – 141.

Kaplan, R. 2004. Responding to the emergence of multiple-drug resistant Haemonchus contortus: Smart Drenching and FAMACHA©. Proceedings of the Georgia Veterinary Medical Association 2004 Food Animal Conference, Irwinville, GA: 1 – 9.

Kumba, F., F., Katjevena, H., Kauta, G., 2003. Seasonal evolution of faecal egg output by gastrointestinal worms in goats on communal farms in eastern Namibia. Onderstepoort Jounal of Veterinary Research, 70: 265 – 271.

Kumsa, B., Abebe, G., 2009. Multiple anthelmintic resistance on a goat farm in Hawass (southern Ethiopia). Trop Anim Health Prod 41: 655 – 662.

Kusilika, L., J., M., Kambarage, D., M., Matthewman, R., W., 1996. Coccidiosis of small ruminants in Tanzania. Small Suminant Research 21: 127 – 131.

Kusiluka, L., and Kambarage, D., 1996. Diseases of small ruminants in Sub-Saharan Africa: Handbook. VETAID. ISBN 0 9522299 5 1

Kusiluka, L., J., M., Kambarage, D., M., Matthewman, R., W., Harrison, L., J., S., Daborn, C., J., 1996. Coccidiosis of small ruminants in Tanzania. Small Rumin. Res. 21: 127 – 131.

Lebbie, S., H., B., 2005. Goats under household conditions. Small Ruminant Research 51: 131 – 360.

Lebbie, S., H., B., Rey, B., Irungu, E., K.,1992. Small Ruminant Research and Development in Africa. Proceedings of the Second Biennial Conference of the African Small Ruminant Research Nerwork AICC, Arusha, Tanzania: 7 – 11.

Leeuw, P. N., McDermott, J. J., Lebbie, S. H. B., 1995. Monitoring of livestock health and production in sub-Saharan Africa. Preventive Veterinary Medicine 25: 195 – 212.

Lengeler, Ch., Utzinger, J., Tanner, M. 2002. Questionnaires for rapid screening of schistosomiasis in sub-Saharan Africa. Bulletin of the World Health Organization 80: 235 – 242.

Magona, J., W., Musisi, G. 2002. Influence of age, grazing system, season and agroclimatic zone on the prevalence and intensity of gastrointestinal strongylosis in Ugandan goats. Small Ruminant Research 44: 187 – 192.

Maingi, N., Gichanga, E., J., and Gichovi, V., M., 1993. Prevalence of gastro-intestinal helminths and coccidial parasites and frequency distribution of some nematode genera in some farms in four districts in Kenya. Bull. Anim. Hlth. Prod. Afr., 41: 285 – 290.

Maingi, N., Krecek, R. C., van Biljon, N., 2006. Control of gastrointestinal nematodes in goats on pastures in South Africa using nematophagous fungi Duddingtonia flagrans and selective anthelmintic treatments. Vet Parasitol. 3-4: 328 – 326

Mehlhorn, H., Schein, E., Ahmed, J., S., 1994. Theileria. In: Kreier JP (ed) Parasitic protozoa, vol 7. Academic Press, San Diego: 217 – 304.

Njeruh, F., M., Kithuka, J., M., Maingi, N., Ombui, J., N., 2004. The Kenya Vereinarian, Vol. 26: 51 – 54.

Ogle, B., 1996. Livestock Systems in Semi-Arid Sub-Saharan Africa. Conference paper: Book chapter Integrated Farming in human development. Proccedings of a Workshop Tune Landboskole, Denmark, 25-29, March, 1996. 238 – 246.

Otte, J., Knips, V., 2005. Livestock Development for Sub-Saharan Africa. Pro_poor Livestock Policy Initiative Research Report, RR Nr.: 05 – 09.

Over, H., J., Jansen, J. and van Olm, P., W., 1992. Distibution and impact of helminth diseases of livestock in developing countries. M-27 ISBN 92-5-103166-5.

Peacock, C., 1996. Improving Goat Production in the Tropics: a manual for development workers OXFAM/FARM-Africa, London, UK ISBN: 0855982691

Peacock, C., 2005. Goats – A pathway out of poverty. Small Ruminant Research 60: 179 – 186.

Pell, A., N., 1999. Integrated crop-livestock management systems in Sub-Saharan Africa. Environment, Development and Sustainability 1: 337 – 348.

Rege, J., E., O., Lebbie, S., H., B., 2000. The goat resources of Africa: origin, distribution and contribution to the national economies. In: Proceedings of the International Conference on Goats, vol. 2, Tours, France, 15–21 May 2000: 927 – 931.

Reinecke, R., K., 1983. Veterinary Helminthology 1st Ed., Bulterworth Durban: 55 – 66.

Restani, P. 2004. Goat milk allerginicity. Jour. Pediatric Gastroenterology and Nutrition, 39: 323 – 324.

Right diagnostic, 2012. Stedman's Medical Spellchecker [on-line] 2007, [cit 4th February 2012]. Available from <http://www.rightdiagnosis.com/medical/coccidia.htm>.

Rosa, F., Peleteiro, M., C., Louza, A. 2008. Sobre alguns parasitas em animais domésticos na cidade Lubango.

Snapp, S., S., Rohrbach, D., D., Simtowe, F., 2002. Sustainable soil management options for Malawi: can smallholder farmers grow more legumes? Agriculture, Ecosystems and Environment 91: 159 – 174.

Sobngwi, E., Mbanya, J. C., Unwin, N., C., 2001. Development and validation of a questionnaire for the assessment of physical activity in epidemiological studies in Sub-Saharan Africa. International Epidemiological Association.

StatSoft Inc. 2012. [program] Statistika version 10 Trial. http://www.statsoft.com/

Thornton, P.K., Kruska, R.L., Henninger N., Kristjanson, P.M., Reid, R.S., Atieno, F., Odero, A. and Ndegwa, T. 2002. Mapping poverty and livestock in the developing world. ILRI, Nairobi, Kenya: 118.

Tolera, A., Abebe, A., 2007. Livestock production in pastoral and agro-pastoral production systems of southern Ethiopia. Livestock Research for Rural Development 19: 12.

Urquhart, G., M., Armour, J., Duncan, J., L., Dunn, A., M., 1996. Veterinary parasitology, 2nd ed. Blackwell Science, United Kingdom: 307.

Vercruysse, J., 1982. The coccidia of sheep and goats in Senegal. Vet. Parasitol. 10, 297 – 306.

Waller, P., J., 1997. Nematode Parasite Control of Livestock in the Tropics/Subtropics: the Need for Novel Approaches. International journal for Parasitology, 27: 1193 – 1201.

Waruiru, R., M., Mbuthia, P., G., and Kimoro, C., O., 1993. Prevalence of gastro-intestinal parasites and liver flukes in calves in Mathira Division of Nyeri District, Kenya. Bull. Anim. Hlth. Prod. Afr., 41: 291 – 296.

Whaley, S., Sigman, M., Bwibo, N., Guthrie, D., Weiss, R.E., Murphy, S., Alber, S., 2002. The Impact of Dietary Intervention on the Cognitive Development of Kenyan Schoolchildren. Research Brief 02-01-CNP. Global Livestock CRSP, Davis, USA.

WHO, 2004. Integrated guide to Sanitary parasitology. WHO-EM/CEH/121/E

Williamson, S., Ball, A., Pretty, J., 2008. Trends in pesticide use and drivers for safer pest management in foou African countries. Crop Proteciton 27: 1327-1334.

Wilson, R. T., 1988. Small Ruminant Production Systems in Tropical Africa. Small Ruminant Research 1: 305 – 325.

Wilson, R. T., 1991. Small ruminant production and the small ruminant genetic resource in tropical Africa. Animal Production & Health Paper No. 88. Food & Agricultural Organization of United Nation, Rome, Italy: 231

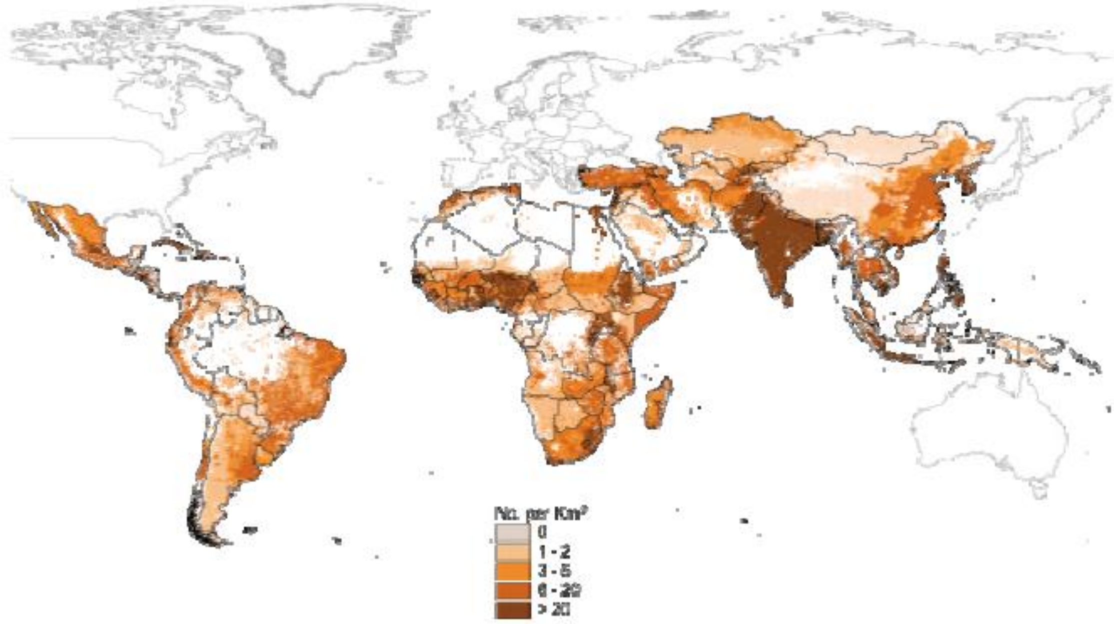
Wilson, R., T., and Light, D., 1986. Livestock Production in Central Mali: Economic Chracters and Productivity Indices for Traditionally Managed Goats and Sheep. Journal of animal Science 62: 567 – 575.

Winrock International, 1992. Assessment of animal agriculture in sub-Saharan Africa. Winrock International Institute for Agricultural Development. Morrilton, AR: 125.

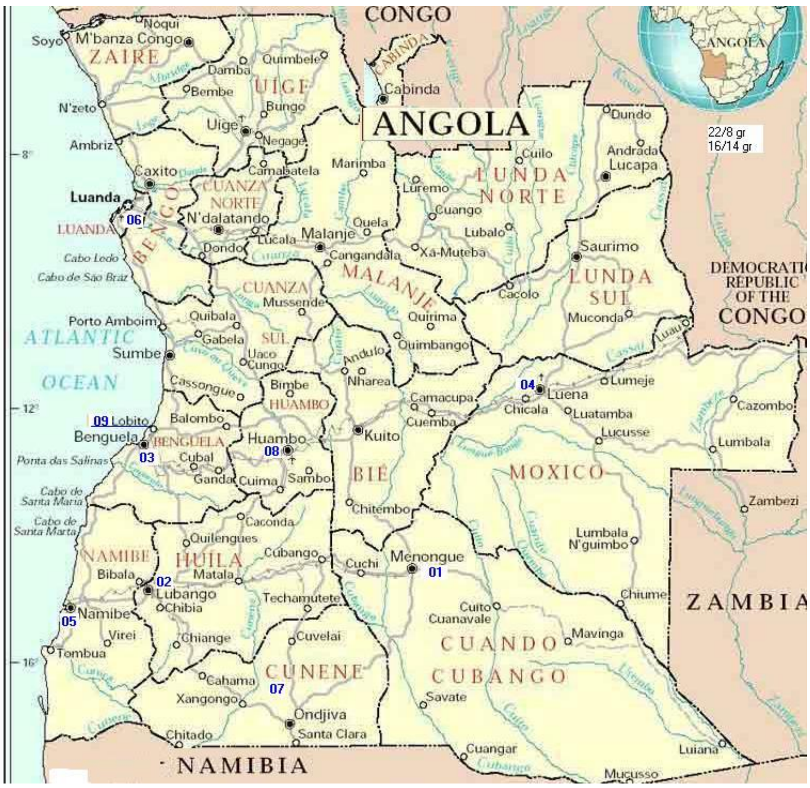
World Bank, 2002. Can Africa claim the 21st century? World Bank, African Development Bank, United Nations Economic Commission for Africa

8. Appendices

Appendix 1 - Density of "poor livestock keepers" by farming system (Thornton et al., 2002**)**



Appendix 2 – Map of Angola (www.uniaonet.com/afangola.htm, 2012)



Appendix 3 - Pre-administered questionnaires for "soba" (head of village)

1. Name of village …
2. In which year was village founded? …
3. How many habitants have your village? ……. Male …. Female ….Children …..
4. How many houses have your village? …
5. How many families have your village? …
6. How many family keep goats?
7. Livelihoods
    a. Agriculture …
    b. Gathering and hunting …
    c. Own business …
    d. Employee …
8. Do your children attend school?
    a. Yes, we have our school
    b. Yes, external professor is coming to our village
    c. No, do not attend
9. How many villages' habitants know write and read? …
10. Which source of water do you used? …
11. Does your village source of energy?
    a. Yes
    b. No
12. How many vehicles are in our villages?
    a. How many cars ….
    b. How many motor bike …
    c. How many bicycles …
13. Which kind of livestock is bred in your village?
14. How many livestock is in village?
    a. Cattle …
    b. Goats …F….M….K….

c. Chicken…
d. Pig …
e. Duck …
f. Others …

15. Which is origin of village's goats? …

16. Which animal housing is used during night? …

17. Which animal housing is used during day? …

18. The goats are feed by?

    a. Pasturage
    b. Pasturage and others as rest of kitchen,…
    c. Salt, vitamins, …

19. Number of newborn kids in rainy season? …

20. Number of died goats ….and kids…?

21. Why do you thing that your goats died? …

22. Source of water for goats? …

23. How often do veterinary visit your village? …

24. Do you take extra care on goats and which? …

25. Did you vaccinate goats in your village? …

26. How many field (ha) have one family?...

27. Which plants cultivate in your village?...

28. Do you use fertilizes? …

29. Do you burn new field? …

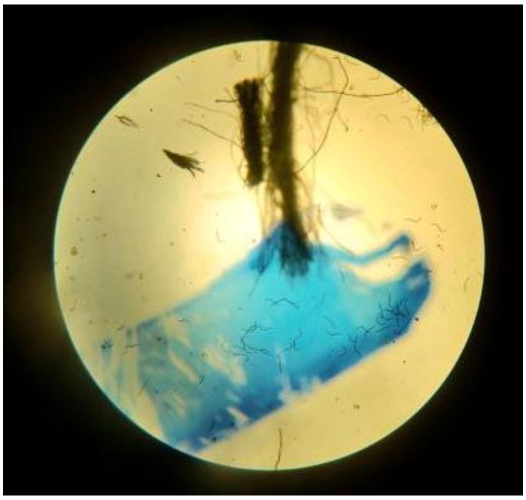
Appendix 4 - Pre-administered questionnaires for "goat keeper"

1. What is your name? …

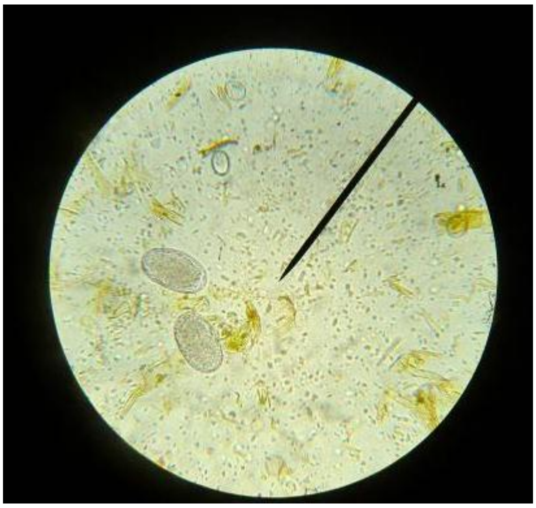
2. How old are you? …

3. Do you know read and write? …
4. How many members have your family (living in the same house)? …
5. Do you have motor bike? …
6. Which animal do you breed and how many?
7. Which animal housing is used during night? …
8. Which animal housing is used during day? …
9. How many goats died during rainy season (How many adult and how many kids)? …
10. Why do you thing that the goats died? …
11. How many newborn kids do you have?
12. Do you take special care about your goats?
13. How many fields (ha) do you have?
14. Do you burn the new field?

Appendix 5 – Trichuris sp., Pulmoes nematoda

Appendix 6 – Mamezia sp., Strongyloides sp.

Appendix 7 – Feacal sample collection

Appendix 8 – Questioners data collections