Sveriges lantbruksuniversitet
Swedish University of Agricultural Sciences

Faculty of Veterinary Medicine and Animal Science
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Breeding and Herd Structure in Livestock-based Agropastoralism Systems in Chepareria, West Pokot, Kenya

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Examensarbete / Swedish University of Agricultural Sciences
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Avel och besättningsstruktur i boskapsbaserade agropastoralistiska system i Chepareria, West Pokot, Kenya

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by Freja Engström

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I would also like to thank Ewa Wredle (SLU) and Gert Nyberg (Vi Agroforestry) for guidance and support during the start-up of the field study in Kitale and Chepareria.

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ABSTRACT

The development towards a sustainable agro-pastoralism started late in Chepareria Division, Kenya, but is today moving fast. The livestock-based agro-pastoralists widely apply crossbreeding with imported exotic breeds for rapid performance improvements. There is a great shortage of breeding- and genetic knowledge and because no long-term breeding programs are practiced there is a risk of losing valuable genetic variation of indigenous breeds. The documentation on the livestock production in Chepareria is inadequate. The aim of this study was therefore to investigate the current breeding strategies and herd structures, as well as the purpose of the animal production. A combination of structured and semi-structured interviews was made on thirty farms in the areas Ywalateke and Pserum. Twenty farms were randomly selected and ten farms were chosen because they were considered to have the best livestock management performance. The number of animals in the herd did not differ between the two areas, neither between the randomly selected nor chosen farms. Crossbreeding was used by 83% of the farmers and 67% of the farmers planned their breeding in some way. The only significant difference (P= 0.05) between the two regions seen was that own bulls were more commonly housed on farms in Pserum.

The purpose of the production was shown to be both for selling and self-consumption. Products produced were; milk, meat, live animals, eggs, manure and hides. The reasons for selling products were predominant to pay for school fees, as education was considered of great importance. The prices given for live animals at the market were shown to differ a lot due to type, sex, and breed. Milk was seldom sold and the daily milk yield was difficult to estimate because of different measuring tools among the farms. For future improvement more detailed investigations have to be done. To launch long-term breeding strategies, blood samples of livestock animal need to be taken to determinate individual genetic composition. A moderate use of crossbreeding should also be considered.

Keywords: Breeding strategy, herd structure, crossbreeding, animal production, livestock-based, agro-pastoralism, Chepareria, West Pokot, Kenya

SAMMANFATTNING

Trots att utvecklingen mot en boskapsbaserad agro-pastoralism började sent i Chepareria Division, Kenya, växer den idag fort. För att snabbare uppnå förbättrade produktionsresultat tillämpar agro-pastoralisterna i stor utsträckning korsningsavel där importerade exotiska raser används. Den stora bristen på kunskap om avel och genetik, samt bristen på långsiktiga avelsprogram, ökar risken för att de inhemska rasernas värdefulla genetiska variation går förlorad. Det finns ingen tillräcklig dokumentation av animalieproduktionen i Chepareria. Denna studie utfördes därför för att undersöka rådande avelsstrategier, besättningsstrukturer och syftet med djurproduktionen i området. En kombination av strukturerade och semistrukturerade intervjuer utfördes på 30 gårdar i områdena Ywalateke och Pserum. 20 slumpmässigt utvalda gårdar och 10 gårdar, som ansågs vara de ”bästa”, ingick i studien. Antalet djur i besättningarna skilde sig inte mellan de två områdena, inte heller mellan de slumpmässigt utvalda gårdarna eller de ”bästa” gårdarna. På 83% av gårdarna tillämpades korsningsavel och 67% av bönderna planerade sin avel på något sätt. Den enda signifikanta skillnaden ($P = 0,050$), som de statistiska analyserna visade, var att det var vanligare att inhysa egna tjurar på gårdarna i Pserum.

Syftet med animalieproduktionen visade sig vara både för försäljning och för egen konsumtion i hemmet. Det produkter som producerades på gårdarna var mjölk, kött, livdjur, ägg, kyckling, gödsel och hudar. Den övervägande anledningen till försäljning av produkter var för att betala skolavgifter, då utbildning ansågs vara av stor betydelse. De gällande priserna för livdjur på marknaden visade sig skilja markant på grund av typ, kön och ras. Mjölk såldes sällan och den dagliga mjölkavkastningen var svårt att uppskatta eftersom olika mätverktyg användes på gårdarna. För framtida förbättringar inom husdjursaveln måste mer detaljerad forskning göras. För att kunna starta en mer långsiktig avelsplanering behöver blodprover från boskapen göras. Detta för att kunna bestämma individers genetiska sammansättning. En försiktig användning av korsningsavel bör också övervägas.

Nyckelord: Avelstrategi, besättningsstruktur, korsningsavel, animalieproduktion, boskapsbaserad agro-pastoralism, Chepareria, West Pokot, Kenya

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1. INTRODUCTION

Kenya is located in eastern Africa, adjacent to Somalia, Ethiopia, Sudan, Uganda and Tanzania. The country area of Kenya is 58 million hectares (ha) where almost 28 million ha are covered by agricultural land (FAOSTAT, 2011). Kenya has a population of 45.5 million, and approximately 78% lives in the rural areas (FAOSTAT, 2010, World Bank, 2015a). In 2014, the total labour force included barely half of the population, of which 14.5 million people work within agriculture (FAOSTAT, 2015). The majority of the people live in the highlands (Landguiden, 2011).

The Kenyan landscape differs remarkably within the country. Unlike the coastline in the east, the tableland rises in the western and central parts (Landguiden, 2011). Due to the altitude, large parts of Kenya have temperate climate including seasons although it is located at the equator. The amount of rainfall differs within the country and only 10% of the total land area is considered as arable land, as it obtains enough rain to be suited for agriculture (Landguiden, 2011). People most affected by environmental impact are living in areas where unreliable rainfalls represent a risk due to lack of non-agricultural opportunities (Makokha et al., 1999). Large and more erratic downpours make it hard for the farmers to get plants to root and survive. Vi Agroforestry (2012) therefore points out the importance of planting trees. Trees not only reduce soil erosion, fix nitrogen and bring shadow that benefits the crops, they also provide the farmers with feed for their animals (Vi Agroforestry, 2012). The large rainfalls and soil erosion makes the essential supply of water, food and feed a daily issue. Kenya possesses 80% low-potential areas. This land cannot support crops with irrigation and therefore extensive livestock production is often common on this land (Muturi et al., 2001).

As much as 60 % of the cattle, and 75% of sheep and goats are housed in the low-potential areas. (Muturi et al., 2001). Even though people in the arid and semi-arid land (ASALs) are well familiar with drought, the long periods without rain cause the farmers losses of animals because of dehydration (Kandji, 2006) and the remaining animals weaken and thereby bring less income in terms of milk, meat and payment at the market. In addition to this, ecological impairment, population growth, political and economic matters are cited by Makokha et. al. (1999) as some of the major reasons for the crises in pastoralism in Kenya.

1.1. Study region

Kenya consists of eight former provinces that are divided into smaller counties. Chepareria is one out of four divisions located in West Pokot County (figure 2), situated in the north-western Kenya, at the border to Uganda (Citypopulation, 2009, Östberg, 1988). West Pokot County has a size of 9100 km^2 and the altitude differs greatly in the area (Hendrix, 1985). In August 2009, City Population (2009) estimated 512 690 people living in the county West Pokot.

This study was carried out in two different areas within the Chepareria Division, Ywalateke and Pserum (figure 2). Ywalateke is located close to Chepareria town, while Pserum is located 15 km away (Östberg, 1988). The altitude in this area differs between 1500-1900 meters above sea level. People living in Chepareria Division are agro-pastoralists with private land and enclosures (Wairore et al., 2015). The only persistent river in the Chepareria Division is Muruny that is supplied with water from the Cherangani hills. The river Iyon flows through Pserum only when it is raining and seasonally join Muruny (Östberg, 1988). During December to March the dry periods

occurs with an average rainfall of 32.5 mm per month (WWO, 2012). Chepareria has no communal water supply and therefore households are dependent on natural resources like water from the river and feed for their livestock.

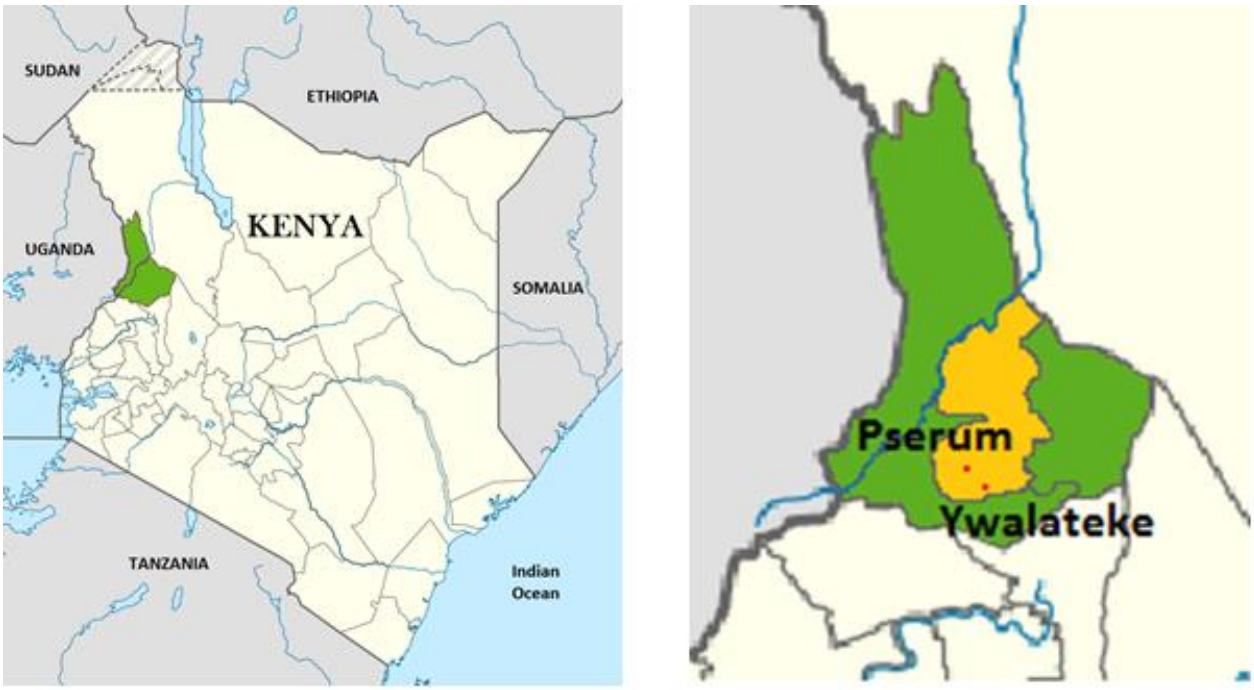

Figure 1: To the left: Location of West Pokot County in Kenya. To the right: Location of the study areas, Ywalateke and Pserum, in Chepareria Division, West Pokot (NordNordWest, 2015. From: https://commons.wikimedia.org/wiki/File:West_Pokot_County_in_Kenya.svg?uselang=sv [Access: 2016-05-07] Modified by Freja Engström).

1.2. Challenges of today

The livestock-based agro-pastoralism in the West Pokot District, in north-western Kenya, is today facing many challenges. Development towards a sustainable agro-pastoralism started late in West Pokot District (Makokha et al., 1999). Due to several factors as underdeveloped infrastructure, social-political factors, lack of financial means, knowledge of and access to modern techniques the improvements in husbandry are moving slowly in the area. Given the poverty in agricultural and livestock dependent rural areas, like West Pokot District (World Bank, 2015b, Kandji, 2006, Makokha et al., 1999), the question of long-term sustainable animal livestock production and an increased efficiency in overall agriculture is important to discuss. Several breeds of cattle, goat and sheep, as well as poultry, are all represented in nearly every household in the Chepareria Division in the district of West Pokot. The local breeds are common, but crosses and a small number of pure exotic improved breeds can be seen. As crossbreeding widens in the Chepareria Division, one item that has to be taken into account is to improve the knowledge of the genetic influence on livestock production among agro-pastoralists in the rural areas. This, together with a deliberate import of exotic breeds and a developed breeding system could improve the animal production (Porter, 1991).

This field study was carried out in cooperation with SIDA (Swedish Development Cooperation) and MFS (Minor Field Study) scholarship, Vi Agroforestry and Triple L. Vi Agroforestry is a Non-Governmental Organization (NGO) mainly active in Kenya, Tanzania, Uganda and Rwanda. It was founded in Sweden during the 1980s and it is a non-political and non-religious organization run voluntarily (Vi-skogen, 2016). A research initiative, *"Triple L - Land, Livestock and Livelihood Dynamics in Dryland Systems, West Pokot Kenya,* was started in 2013. The aim of that ongoing project is to understand and analyse the changes connected with enclosures and increased vegetation. Students (MSc and PhD) from both Sweden and Kenya are encouraged to contribute to the research, in collaboration with Triple L, by conducting own projects.

1.3. Aims

Long-term breeding programs are rarely applied in the division of Chepareria. Today, the breeding is mainly planned only for the next, or a few, generations to come. There is nearly no documentation done on the structure and breeding of livestock herds in the area. Therefore, the main objectives of this investigating minor field study was to collect data on the phenotypic and genetic characteristics of the animals, as well as on the herd structure of livestock and what breeding strategies are applied, among farmers in Ywalateke and Pserum in the Chepareria Division. The study was further done to get a picture of the purpose of livestock for the livelihood. The focus was on ruminants (cattle, goats and sheep) but the existence of other species was also noted. The aim of this baseline study was also to contribute to a broader base for further studies in the area, which in turn can lead towards a more secure animal production and retention.

Alongside this thesis, the study will end up in a leaflet of one A4 page to send back to Vi Agroforestry's headquarter in Kitale, West Pokot, Kenya. This leaflet will let the people in the study area take part of the results. The leaflet will include the main findings and conclusions. It will also give a few relevant adaptable advices in how to improve their animal breeding, with local conditions taken into account.

2. ANIMAL HUSBANDRY

Since early stages of domestication human has through selection affected the gene composition of animals by choosing the most responsive animals best suited for the wanted trait. Adaptability of cattle changed their behaviour and their physical structure. The cattle changed and weakened to serve its master. This is shown in smaller brain, reduced body size and decreased ability to cope with danger. At first, domestication of mammals often shows in decreased size before extreme differences in phenotypes are shown (Porter, 1991). This strengthens the indication that livestock, as the small east African short-horned Zebu, still are adapting by natural selection with influence from humans as they are dependent on them. But, the people in the Chepareria Division do not yet control the breeding by selection of animals for recruitment or artificial insemination, where man decides which traits are needed according to human preferences.

Domestication has during thousands of years given rise to local types well suited for specific demands and needs, e.g., for the climate or diseases in a certain area (Porter, 1991).

2.1. Livestock management

To be able to manage the water and pasture needs of the livestock, the Kenyan pastoralists have earlier relied on systematically moving the herds, living as nomads. Today several pastoralists buy their own land and settle down. To manage the need of feed and food, new knowledge of agriculture is applied. The pastoralists have to be opportunists and therefore goats have partly been replaced by cows to adapt to the changes (Kandji, 2006). A seasonal grazing pattern, by movement of the herds, has been essential in order for the pastoral livestock to survive. Pastoral enclosures were developed even before the colonial period. While men were away herding, the women opened up small plots for crops. To keep animals off, thorny branches were used to enclose the plots. Since the people in West Pokot started to settle in one place, the lifestyle of keeping animals inside or outside enclosures has developed and increased (Makokha et al., 1999). Today, the great majority of agro-pastoralists in the Chepareria Division have enclosed plots for food and feed production nearby their houses.

There has been improvement in animal feed management in West Pokot. Animals are to a large extent kept in enclosed pastures, which has shown a result of improved body condition. To cut and store grasses and maize stover is also becoming more common (Makokha et al., 1999). This increases the possibility to be able to supply animal feed even during drought and dry seasons.

2.2. Purpose of the production

Livestock is mainly held for self-consumption and as an insurance to cover several cash needs (Makokha et al., 1999). The main reason for housing cattle in the tropics is for human survival and the production is a secondary matter (Porter, 1991). It was estimated in 2010 that 30% of the Kenyan population are suffering from undernutrition (FAOSTAT, 2013) and Muturi et al. (2001) mention the milk consumption as health promotive, because it has been shown to decrease malnutrition. Makokha (1999) reports that bulls, goats and sheep are sold to cover larger cash needs as school fees, hospital bills and supplemental food. Cows are not commonly sold if they are not old or culled. To meet smaller cash needs, as minor investments in the farm, consumption of food and clothes, goats and sheep are sold (Makokha et al., 1999). This was also shown in a survey, carried out in the central and western part of Kenya, where 48% of the participating households kept both goats and sheep (Kosgey, 2004). The purpose of keeping sheep and goats was comparable to Makokha et al. (1999) for socioeconomic wellbeing. Further reasons were to secure a regular income, produce milk, meat and manure but also as an insurance against emergencies (Kosgey, 2004).

3. LIVESTOCK

Cattle, goat, sheep and poultry are the most common livestock in Kenya. In 2014, the number of heads were for: cattle 17.8 million; goats 25.4 million; and sheep 17.4 million (FAOSTAT, 2014). In West Pokot County the herd size can vary among seasons and years. As for counting animals, “not many” (<10), “many” (10-100) and “very many” (>100) are replacing exact numbers. Excluded are young animals and animals loaned to relatives and friends as a security of survival (Makokha et al., 1999).

3.1. Breeds

In West Pokot District the local breeds of livestock have been used for a very long time. The animals are frequently kept for dual- or multi-purpose. Local breeds are, owing to centuries of adaptation, suited for the environment and local needs in the area (Porter, 1991). The local breeds in Kenya are often named after the local district where they are to be found. Therefore, the ruminant breeds in West Pokot are called Local Pokot Zebu, Goat or Sheep. Cattle, goats and sheep are the main type of livestock in the Chepareria Division (Makokha et al., 1999). Currently, crossbreeding of local breeds and housing of pure exotic breeds are spreading in the area. Crosses are popular not only to increase the milk yield but also to gain larger animals which bring higher income at sale.

3.1.1. Cattle

Humped breeds dominate within tropical cattle production. This includes two types; Thoracic-humped cattle and stabilized crossbreeds possessing cervico-thoracic humps (Payne and Hodges, 1997). Several exotic breeds of *Bos taurus* have been introduced and crossed to *Bos indicus* (Porter, 1991). In Chepareria the Small East African Short-horned Zebu (named Local Pokot Zebu in the area) is most commonly seen among the herds, pure as well as crossed. Additionally, breeds occurring on the farms are Sahiwal, Ayrshire and Friesian. Table 1 shows the pros and cons with indigenous respectively exotic breeds.

Table 1: Pros and cons for indigenous and exotic breeds housed in tropic environment according to Porter (1991), interpreted by Freja Engström.

	Pros	**Cons**
Indigenous breeds	Resistant to several local diseases and parasites	Low milk yield
	Genetic adaptation to the climate	Small animals
	Low need of veterinary control	Mature late
	High quality of milk	Short lactations
	Ability to survive on low quality food and limited water supplies	Long dry period
	Easy calving	
	Tolerant to drought	
	Able to walk long distances for feed and water	
Improved/exotic breeds	High milk yield	Low resistance to local diseases and parasites
	Large animals	Not genetically adapted to the climate
	High revenue at the market	High need of veterinary control
		Demand of high nutritional feed
		High demand of good management
		Low tolerance to drought.

Small East African Short-horned Zebu or Local Pokot Zebu

The small short-horned Zebu is the dominant type throughout Kenya and Tanzania. This type of cobby zebu has a numerous of varieties which makes it difficult to place them into a certain breed. The small Kenyan Zebu has a thoracic-hump and is used for all needs, such as milk, meat, draft and transport. (Porter, 1991).

Kenyan Boran

According to Porter (1991), the initial Boran zebu was fairly long legged and large, and mainly used for milk and draft. It originates from the Ethiopian semi-nomadic tribe Boran. Many decades ago the British colonists, in parts of the semi-arid highlands of Kenya, started to improve Boran for beef by crossing with imported breeds as Hereford. This breeding resulted in the Improved Boran, also called the Kenyan Boran. The exterior shows medium length legs and a straight top line. The colour is commonly white with black freckles, but some are red, fawn or black. The Kenyan Boran has well-developed dewlaps and thoracic humps. The medium long head with small ears usually carries short, blunt and thick horns. In 1991, the Kenyan Boran was one of the most common beef breeds in Africa, due to 40 years of ongoing controlled breeding. The improved breeding has resulted in cattle with large muscled bodies. Unfortunately, as the beefiness increases the need of good management as well. Also the zebu's resistance to tick-borne diseases and ability of easy calving decreased with improved meatiness (Porter, 1991).

Sahiwal

In 1991, Kenya had an important role in Africa as a major source of Sahiwal genetic material, both stock and semen. It has been useful in Africa when introducing *Bos taurus* of milk or meat breeds to different climate zones, as the Sahiwal already possess the wanted adapted qualities. Among *Bos indicus*, the Sahiwal has no equal breed to be compared to because of its significant higher milk yield. (Porter, 1991). The Sahiwal is a dairy breed documented in the herdbooks. The lactation is maintained for about 272 days and the average milk yield per lactation is 1852 kg milk with a milk fat of 4.6%. It has traits from the Zebu and likewise a good resistance to tick borne disease. The colour is often reddish-dun usually with white marks, or solid coloured, but not commonly white. The birth weight is fairly high, on average 23.2 kg for males and 21.3 kg for females. Population data from 2010 show a number 50,000-60,000 individuals and it is increasing. AI is used among the farmers in Kenya and a conservation program does exist (DAD-IS, 2015b).

Other breeds of cattle

The Ayrshire is an exotic dairy breed. In 2010 the population in Kenya was estimated to between 1.2 million and 1.4 million individuals and the numbers are increasing. Of those, only 2082 cows are registered in herd books. AI is used. The colour is red and white (DAD-IS, 2015a).

Also Friesian is an imported exotic dairy breed. The population of Friesians in Kenya was 1.9-2.2 million in 2010. The data of breeding females showed a number of 885,901 in 2007 and the number of females registered in herdbooks in 2010 was 6 043. AI is used (DAD-IS, 2007). The colour is black and white.

3.1.2. Goats and sheep

In Chepareria the Kenyan indigenous goats, Small East-African goat (Local Pokot Goat) and white Galla goat, are the dominating breeds of goats on the farms. Some specimen of other breeds like Toggenburg can also be seen among the herds, but these are not common. Regarding sheep, the Maasai sheep (Local Pokot Sheep) and the exotic imported Dorper sheep are the two breeds occurring in the households.

Small East-African Goat or Local Pokot Goat

The local goat can be found all over Kenya and is adapted to harsh conditions. The breed can reproduce all year. It can have all colours or combination of colours (DAD-IS, 2016c). As the local goats are adapted to environmental conditions they are more resistant to local diseases and parasites than improved breeds (Baker et al., 1998).

Galla Goat

The large Galla goat is recognised by its white colour. In comparison to the Small East-African goats the white Galla goat is less resistant to local diseases and parasites (Baker et al., 1998). Njoro (2001) mentions that greater milk yield and growth are favourable traits of the Galla goat. It can gain weight until eight years of age and females continue to reproduce until ten years of age. After longer dry seasons, with insufficient feed and water supply, they have a great capacity to gain lost weight (Njoro, 2001).

Masai Sheep or Local Pokot Sheep

The red-brown Masai sheep is an indigenous breed housed for meat. The average weight for males and females are 41 kg and 32 kg, respectively, and the daily gain is on average 97 g. Females are 18 months on average at first parturition and have an interval of 310 days between parturitions. The twinning rate is about14% (DAD-IS, 2016b).

Dorper Sheep

The exotic Dorper sheep, with its black head and white body, is mainly used for meat production. The colour can also occur in white unicolour. The average daily gain of 180 g is high, compared to the Masai sheep. The carcass weight is 19 kg. At first parturition females are on average 11.5 months. The litter size is 1.27 born lambs in average and the milk fat is 7.1% (DAD-IS, 2016a).

4. BREEDING

As a response to comparatively low milk yield and slow growth in local breeds, new exotic breeds of cattle, goat and sheep have recently been introduced to bring better outcome. Today, a lot of crossbreeding is used in Eastern Africa (Ahuya et al., 2009), as well as in Chepareria Division. The aim of crossbreeding is mainly to get larger animals, which automatically provides higher milk yield and more meat compared to local breeds. The benefits of increased cattle production, showed in higher milk yield and larger animals, is in conflict with the challenges of higher requirement of feed and water supply as well as extended animal health care due to use of breeds not adapted to the area (Porter, 1991). Furthermore, as various improved exotic breeds are introduced to the herds Porter (1991) states that, with the popularity of new breeds the gene pool decreases, and therefore preservation of indigenous types should be taken into consideration to preserve the diversity.

A breed is defined as a group of animals that can easily be identified as a member of a specific group, due to a refinement of a type within a specimen. Animals of the same breed are recognized by external and productive traits. They have to be able to produce offspring without any unrecognizable qualities or exterior for that certain breed. (Porter, 1991). As the local breeds in Kenya, according to Porter (1991), are similar but have a great variety, it is hard to define specific breeds among the Zebus in West Pokot.

4.1. Breeding objectives and strategies in low-input systems

Crossbreeding is widely used to improve the genetic potentials of a more favourable performance (Mbuku et al., 2015, Peacock et al., 2011, Mestawet et al., 2014). The success of main objectives of crossbreeding programs in low-input countries can be decreased due to lack of compatible genotypes for desired traits, high requirement of input, and discordant benefit (Mestawet et al., 2014). To optimize the benefits of breeding both genetic and environmental methods have to be applied. Not seldom, these two approaches are difficult to apply in developing countries where it is hard to control the impact of nature and the infrastructure is inadequate (Payne and Hodges, 1997).

In developing countries, the focus for improvement of cattle is on the limiting factors rather than changing the surrounding environment (Payne and Hodges, 1997). These limiting factors can according to Payne & Hodges (1997) be replacement of low potential local breeds or improvement of reproduction traits, as well as to enhance resistance to a ravaging disease. Due to the direct increase of performance of milk and beef, when introducing exotic breeds, the recommendations of a careful and slow crossbreeding has not been followed and imports have not been documented. The imported breeds do not have the ability to survive or perform fully in the tropics. (Payne and Hodges, 1997).

Despite frequent use of exotic dairy goats in different breeding programs across Eastern Africa, the information on performance in smallholder production is scant (Ahuya et al., 2009). The presence of sustainable breeding programs for small indigenous ruminants in the tropics were found to be rare (Kosgey et al., 2006). The breeding objectives of a low-input producer have to agree with and suit the expected outputs and the production system. A successful breeding program cannot imply high risks for the farmer. Therefore, it has to be moderately simple and cheap, as well as involving the producer (Kosgey et al., 2006). In a low-input system, a three-breed crossed goat can be used with benefit if it is viable concerning infrastructure and organization of breeding programs (Mbuku et al., 2015). In addition a simulation study carried out by Mbuku et al. (2015) showed that using a three-breed crossbreeding system, with Small East-African goat doe and Galla goat as first sire, and an Improved Boer goat as terminal sire, gained higher amount of meat than any pure breed line of Small East-African goat, Galla goat or Improved Boer goat, or a two breed rotational crossbreeding system with Small East-African goat and Improve Boer goat. On the other hand, the doctoral thesis by Zonabend König (2016) showed that pure breeding of Red Maasai sheep was generally beneficial over terminal-sire crossbreeding with Dorper sheep, especially if the environment was harsh.

Traits as growth rate, tolerance to drought and heat, disease resistance, fertility, and temperament were shown, in a PhD thesis by Kosgey (2004), as important for breeding both goats and sheep in the tropics. It further stated that the Red Maasai sheep and Small East African goat are considered as drought and heat tolerant but still rated low regarding growth rate and fertility. Despite this, indigenous breeds were more favourable compared to crosses even though size, besides behaviour, was one of the most preferable traits when breeding males. Farmers using their own males as recruitment animals normally keep the males for approximately 2-3 years. Exotic and exotic x indigenous genotypes generated higher payoffs at sale due to larger body size (Kosgey, 2004).

4.2. Breeding in commercial production

Crossbreeding between breeds in commercial production is commonly used for several reasons. According to Simm (2010) the motives are to:

1 ***Increase the efficiency and profit of the overall production*.** For example, as for sheep and beef, when using a male within a breed with fast growth and good carcass properties when mating a smaller female within a breed with high reproduction ratio and good maternal behaviour.

2 ***Get an intermediate offspring with the characteristics of two more extreme parental traits.*** For instance, when crossing a beef sire with a dairy cow, the female offspring will obtain a faster growth than the maternal breed as well as higher milk yield in comparison to the characteristics of the paternal breed.

3 ***By repeated crossing establish a new breed***. This happened in Europe during the 1960s and 1970s. Bull semen, from a certain breed, was continuously imported to fertilize the females of the same herds. Those two decades gave rise to numerous of new breeds of beef cattle in Europe. Likewise, the North American Holstein has spread in temperate countries by introduction to indigenous populations upgrading their local herds.

4 ***Be used when creating composite breeds.*** To establish a composite breed, commonly two or more diverse breeds are required. When involving four breeds (A, B, C and D) the F1 generation includes two types of crossbreeds (AB and CD) having half of each parent's genes (figure 1). When mating individuals from the two different F1 generations, the next generation F2 have a quarter of genes from each bread (A, B, C and D). This way of crossbreeding makes the variation of inherited genes wide and through selection the favourable characteristics can be stabilised.

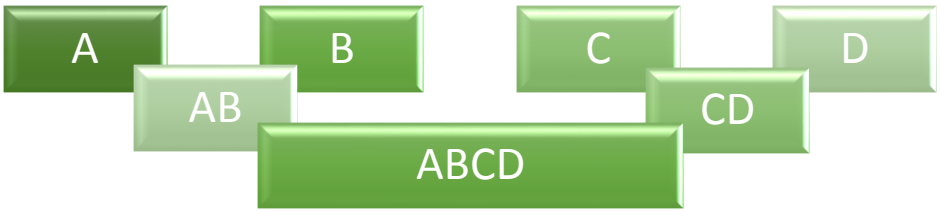

Figure 1: Scheme of the possible crossbreeds for generation F1 and F2 when using four breeds; A, B, C and D, as parental animals. (Made by Freja Engström, 2016-02-13)

5 ***Introduce new variation to small breeds containing few individuals.*** Inbreeding can occur in numerically minor breeds when enough unrelated individuals are not available. Thereby, genetic improvement is not possible. Another breed can be introduced, with low intensity, to avoid further inbreeding.

6 ***Introduce a single gene.*** Integration of a single gene for a certain trait can be done by controlled backcrossing. This is done with the aim to retain only the desired gene from the new breed. The carriers of the gene can further, after various generations of backcrossing, be mated to bring offspring heterozygous for the new gene.

7 ***Exploit heterosis.*** The expected outcome when crossbreeding is to get offspring with a performance level in the middle of the parental animals. Not seldom, the advantages of crossbreeding are even better than midway between parents. The performance, above midway values, is called heterosis.

5. MATERIAL AND METHODS

To carry out this study, data collection, interviews, and subsequent statistical analysis, were made.

5.1. Data collection

During previous years, with a starting point in 2001, the Vi Agroforestry in the region has carried out interviews in around 300 pastoral households. To accomplish this baseline survey interviews on 30 of these 300 pastoral households were made during September and October. Regarding the approaching dry season, normally starting in December, a timetable of six weeks for the 30 interviews was set. This was done to minimize the environmental impact on the study. A changing climate, as rising temperatures, influences the availability of water and feed, and thereby also the number of animals in the herds. The two areas, Ywalateke and Pserum, were selected to be investigated as they seemingly differ in cover of vegetation and soil erosion. Pserum is to be considered as the harsher area. Regard was also taken to the ability to reach the farm and only livestock farms with enclosures were included in the survey. The farms in the two areas were assembled on a list. 15 farms from each area were chosen from that compiled list, 10 randomly selected and 5 chosen farms. The 5 chosen farms were elected by an employee of the Triple L organization, active in the area. These selected farms were considered to have the best livestock management performance according to hearings. The selection is clarified in figure 3.

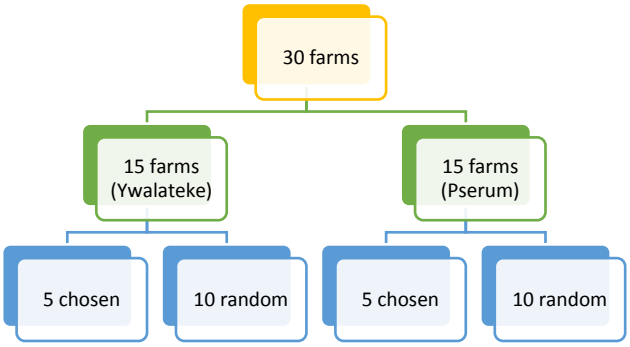

Figure 3: Scheme of the selection of farms.

A local guide, who also acted as interpreter, and boda boda drivers (mc-taxi drivers), all well acquainted with the area, were necessary for the transport to each farm. The respondent was, if possible, contacted by phone beforehand, but the majority of farmers were visited without knowing about the interview as they could not be reached. Thus, a short presentation of each person participating in the session was always done to get the respondent aware of the reason for visit. Ethical aspects were taken carefully into account. All farmers were kept anonymous and therefore not mentioned by name in the thesis. The respondent decided if the interview was to be conducted or if she or he did not want to answer any particular question asked.

5.2. Questionnaire and interviews

A questionnaire (appendix 1) outlined beforehand was made to facilitate the interviews. Structured interviews were combined with semi-structured interviews. Triangulation of methods and data was crucial for this qualitative study. As the study was done in cooperation with Ditte Löfqvist (2016),

compiling a study of the nutritional value of pastures on the same 30 farms, the questionnaire covered both topics: breeding and herd structure of animal livestock, and pasture practices. This approach, to combine the two topics into one questionnaire, was chosen to make one interview only at each farm visit. In this particular study only results concerning breeding and herd structure are presented. The questionnaire was created to be similar to the one in Antonia Grönwall's (2015) earlier master thesis to cover the same topic and to make it easier for others to combine and compare the data of the studies. The interpreter was always present during the interviews. The interviews were either made in English or in the local language Pokot. At occasions where the respondent had no or little English language skills the interpreter was translating the whole session. During interviews where the respondent knew English, the interpreter was participating to help if any language issues occurred. The answers were written down by the student (me) by hand as the interview proceeded. The data was transferred to a computer and on a USB-stick at the end of the day. Photographs of livestock were taken for additional complementary documentation of different phenotypic and genetic characteristics. Local observations of livestock during the visits were also recorded. In addition, a study visit, including an informative interview, at Nasukuta Livestock Improvement Center was made to get an overview of their specific knowledge of animal breeding in the area.

5.3. Statistical analysis

To analyse the results statistically, the questionnaire and its appurtenant answers were compiled in Netigate's online community service for surveys and studies. The data were in addition put into tables in Excel for further use in Minitab for statistical calculations. As data from this field study tended not to be normally distributed no t-test was made, but Kruskal-Wallis tests, Cross Tabulations and Chi-square tests were used.

The hypotheses tested were:

- The farmers in Ywalateke house more animals and gain higher production yields than in Pserum
- The chosen farms (5 in each area) house more animals, practice crossbreeding and plan their breeding more than randomly selected farms
- Educated farmers practice crossbreeding and plan their breeding more than farmers without any education
- The approach of keeping own males differs between the two areas

Tables, diagrams and photographs were mainly used to present the structure, phenotypic and genetic characteristics, and breeding strategies of livestock. Milk yield and prices of various products when selling were also compiled in tables. Replies to more semi-structured designed questions were summarized and categorized by the most common replies occurring.

6. RESULTS

The analyses of the hypotheses showed no significant results of differences in number of animals and greater production yield between the two areas investigated. The expected outcomes, that the chosen farms would house more animals, practice crossbreeding and plan their breeding more widely than randomly selected farms, were not proven. It was further shown that the education level of farmers did not impact the performance of crossbreeding and planned breeding. The

approach of keeping own billy or ram did not differ between the two areas, but for bulls a significant difference (P=0.05) was shown between Ywalateke and Pserum; own bulls were more commonly housed in Pserum.

6.1. Respondent information

Of the 30 respondents participating in this field study, the gender distribution was equal between women and men. The average age was 39 years old, the youngest and oldest age spread from 21 to 65+ years. Of all respondents, 50% had such education as from primary school, secondary school, college and/or university. Nine people had other jobs besides working on the farm. Among those nine farmers, five worked as teachers, one was the chief of Pserum and another chief of an area outside the investigating area. The last two participants were the head of Ywalateke and a salesperson of sugar. The most common number of people working on the farm was 2 (23%). Further, 7 (20%), 4 (13%) and 6 (13%) people was the most common. On 28 farms everyone in the family was working with the animals, only 2 households had people from outside the family working at the farm.

6.2. Structure of livestock

The livestock represented on the visited farms were cattle, goats, sheep, poultry and donkeys. Two households moreover kept cats and a dog. Cattle were present on all 30 farms. Goats, sheep and chickens were also represented largely, as shown in figure 4. The number of farms housing a certain type of animal were: 30 for cattle, 29 for poultry, 28 for goat, 26 for sheep, 5 for donkey and 3 for others.

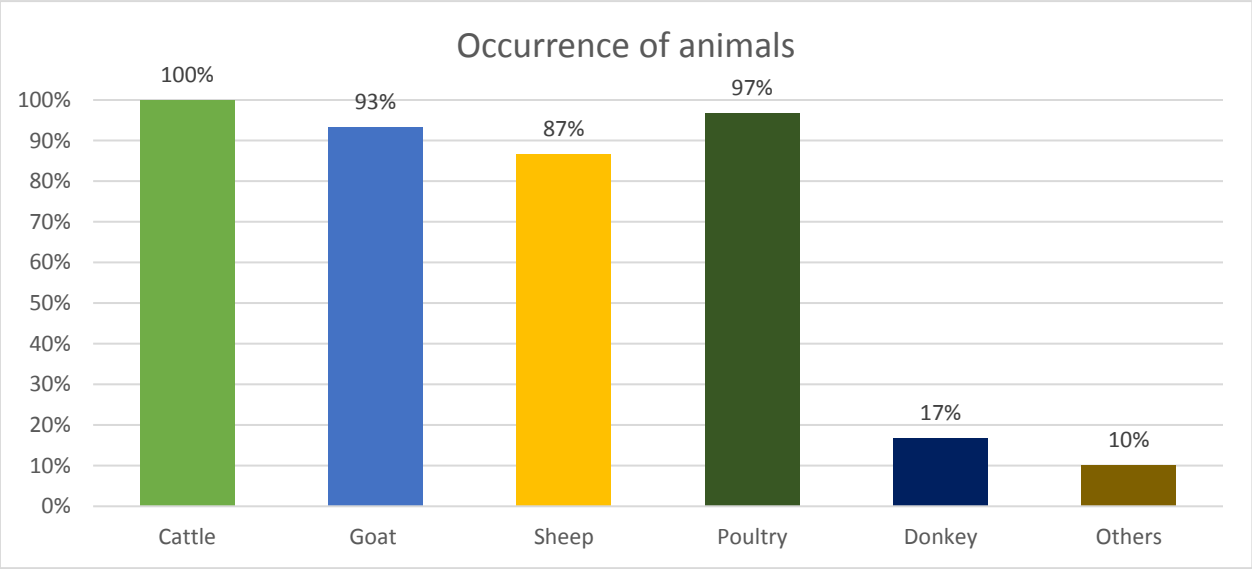

Figure 4: The diagram shows the occurrence (in %) of animals housed on the farms.

The total number of ruminants held in livestock production in the two study areas was 1767 heads, with a mean value of 59 animals. Kruskal-Wallis tests showed no significance between the total number of cattle, goats or sheep, between the two areas. There was no significant difference between the apparently best performing farms and the randomly chosen farms.

The distribution of females, males, and young animals in the herds are presented in table 2, where each species is divided into three groups; females (f), males (m) and young animals (less than one year of age (<1 y)). Additionally, the total number of each species, represented on the farms, is presented. Also the maximum, minimum and range of number of cattle, goats and sheep can be seen. Female ruminants were shown to be of majority in the herds (table 2). On average, one male only for each species and herd was housed on the farms. Young cattle accounted for 22% of the total number of cattle. For young goats and sheep, the results were 18% respectively 17% of the total number. An attempt to calculate the survival of females was done, but as the actual distribution of age in the herds was unreliable it was not possible.

Table 2: Sum, mean, SD, min., max. and range values for cattle, goats and sheep, sorted into three categories; f (females), m (males) and <1 y (young animals, less than one year)

	Cattle				Goats				Sheep			
	f	m	< 1 y	tot. (n=30)	f	m	<1 y	tot. (n=28)	f	m	<1 y	tot. (n=26)
Sum of heads	443	24	130	597	539	30	123	692	366	29	83	478
Mean	15	1	4	20	20	1	5	25	14	1	3	18
SD				20				22				15
Min.				4				0				0
Max.				113				102				64
Range				109				102				64

6.3. Phenotypic and genetic characteristics of livestock

When visiting the farms several breeds and crossbreeds were seen. It was shown that the majority of the 30 farmers housed one breed or crossbreds. For cattle it was more common to keep two breeds than for goats and sheep. Three breeds or crossbreeds were kept by three households for cattle only.

The breeds of cattle seen on the farms are presented in table 3. The breeds were: Local Pokot Zebu (LPZ) and Sahiwal (S) (figure 5 and figure 6), as well as the exotic breeds Ayrshire (A) and Friesian (F). The study indicated that the LPZ was represented on more than half (16) of the 30 participating farms. Crossbreeds of LPZ cow, with S as sire, were also a common combination (figure 6). Animals of pure breed S and A were seen on three respectively two farms. Crossbreeds of AxS, AxF and SxF did also occur.

In table 4, the number of farmers housing a certain breed or crossbreds of goats or sheep is shown. For goats: Local Pokot goat (LPG), Galla goat (GG), and Toggenburg goat (TG), and for sheep: Local Pokot sheep (LPS), Dorper sheep (DS), and Merino sheep (MS), were represented. The most common among goats were crossbreds of LPG and GG, half of the farmers had such a combination. Further, nine farmers had pure GG and five farmers had pure LPG. Two households had the combination of GG and TG. Regarding sheep, the DS sheep was represented on 36.7% of the farms and was thereby the most popular. Crossbreds of LPS and DS were seen on nine farms, and pure breeds of LPS on five. LPSxM and DSxMS were only present on one farm each.

Table 3: Number and amount (%) of the 30 farmers housing a certain breed or crossbreeds of cattle

	Cattle									
	Pure breeds			LPZ crossbreeds				Other crossbreeds		
	LPZ	S	A	LPZxS	LPZx(LPZxS)	LPZxA	LPZx(LPZxA)	AxS	SxF	AxF
No. of farmers	16	3	2	12	1	5	2	2	1	2
Proportion of farmers (%)	53.3	10.0	6.7	40.0	3.3	16.7	6.7	6.7	3.3	6.7

Table 4: Number and amount (%) of the 30 farmers housing certain breeds or crossbreeds of goats and sheep

	Goats				Sheep				
	Pure breeds		Crossbreeds		Pure breeds		Crossbreeds		
	LPG	GG	LPGxGG	GGxTG	LPS	DS	LPSxDS	LPSxMS	DSxMS
No. of farmers	5	9	15	2	5	11	9	1	1
Proportion of farmers (%)	16.7	30.0	50.0	6.7	16.7	36.7	30.0	3.3	3.3

Photos were taken to substantiate the different phenotypic and genetic characteristics among livestock. In figure 5, 6 and 7 below LPZ, LPZ x S, S, LPG x GG, LPS and DS are shown in pictures. Additional photographs of breeds and crossbreeds are presented in appendix 1. The photos show livestock of farmers that responded that they only had one breed or crossbreds per species. This way, we limit the risk of mixing different breeds by phenotype.

Figure 5: Various phenotypic characteristics of LPZ.

Figure 6: Left: Crossbreed cow of LPZ x S. Middle: Crossbreed cows of LPZ x S. Right: Pure breed S bull.

Figure 7: Left: A pure breed GG male with a flock of LPG and LPG x GG females and offspring. Middle: A brown LPS. Right: Pure breed DS with its characteristic dark head, together with white GG.

6.4. Breeding strategies

As documentation on livestock production is scarce among farmers in Chepareria, more sustainable breeding strategies are difficult to apply. Only two farmers kept any kind of documentation of the animals and their production. One of those kept a notebook for cattle and goats including: daily milk yield and its current price, birthdate, number and sex of the new born, number of animals sold, and at what price. The second farmer merely kept documentation of the single pure breed Ayrshire cow. The date of purchase, number of calving and sex of offspring were noted. Remaining production performance was stored in the personal memory, like for the other 28 farmers. For recognition of animals, the 30 visited farmers had put their family mark, by a cut (26) or burn mark (4) in the ear of cattle, goats and sheep.

6.4.1. Planned breeding

Of the 30 respondents, 20 (67%) replied that they do plan their breeding (table 5). The frequency (*f)* of in total 35 responses, given by the 20 current farmers, was distributed into seven categories. To the supplementary question of why or how planned breeding was applied, the main approach for all ruminants was listed as follows:

- improving by the choice of male to use on all females (*f* 11)
- use crossbred or improved bull in order to generate larger animals, more milk and thereby increased income (*f* 11)
- use pure breeds only (*f* 7)
- breed with local breeds, not only to maintain the resistance to diseases and parasites, but also to get animals suited for the environment (*f* 2)
- borrow a bull from neighbour (*f* 2)
- use AI (*f* 1)
- improve the existing Sahiwal breed (*f* 1)

6.4.2. Crossbreeding

Crossbreeding was being used by the great majority (25) of the 30 respondents and there were no significant differences between the two study areas (table 5). The frequency of in total 35 responses, given by the 25 farmers, was distributed into five categories. To the supplementary question of why crossbreeding was practiced, the general causes for all ruminants were listed as follows:

- increase milk yield (*f* 18)
- gain larger animals for more meat (*f* 17)
- get better payoff for both milk and live animals (*f* 16)

- improve the livestock animals (*f* 3)
- avoid breeding to large animals due to its higher demand of feed, keep genes of local breeds (*f* 1)
- local grass suits crossbreed better than pure improved breeds (*f* 1)

Table 5: Positive replies in the two study areas, selected and random farms

	Ywalateke (n=15)			Pserum (n=15)			Both areas (N=30)
	Selected (n=5)	Random (n=10)	All (n=15)	Selected (n=5)	Random (n=10)	All (n=15)	
Planned breeding	4	7	11	4	5	9	20
Crossbreeding	5	8	13	5	7	12	25
Replacement animals	5	10	15	5	10	15	30
Keep all females	5	10	15	5	10	15	30
Own bull	4	4	8	5	8	13	21
Own billy/ram*	5	8	13	4	9	13	26
Keep all new born	5	10	15	5	10	15	30
Record of animals	1	1	2	0	0	0	2

*Two farmers neither house goats or sheep

6.4.3. Replacement animals

All 30 households were using their own animals for replacement and all females were kept in the production (table 5). New offspring were mainly born seasonally. For cattle from April to September; for goats in August and September; and for sheep in March and September. Sheep had the highest tendency to give birth throughout the year. Out of the 28 households keeping goats and sheep, 26 had their own billy and ram (table 5). The Kruskal-Wallis test showed a significance difference (P=0.05) between the two areas, Ywalateke and Pserum, in keeping own bulls. In Pserum 13 participants were keeping their own bulls compared to 8 in Ywalateke. Concerning the period of keeping the same reproductive males in the herds, an average of maintenance for two and a half years was calculated for bull, billy and ram. Only one farmer had no males at all at his farm as he did not house any goats or sheep, and nor own bull among the cattle. To avoid inbreeding, the approach widely used was to keep own males (*f* 26) in order to sell and buy a new one after an average of 2.5 years (*f* 23). More methods practiced was to borrow or change bull with a neighbour (*f* 9), not to keep own males (*f* 6) and one farmer use AI on the single pure breed cow in the herd (*f* 1).

Requested traits for replacement animals were sorted into five criteria. The mentioned strategies are listed by frequency:

- breed animals with large bodies (*f* 16)
- choose the males by the breed (*f* 12)
- keep the females that brings the highest milk yield and breed for more milk (*f* 7)
- breed animals suited for the environment (*f* 6)
- breed animals with good health (*f* 5)
- use the males available for the moment, when females are in heat (*f* 3)

6.5. Management

24 farmers had been, or were still, cooperating with Vi Agroforestry. The average of ongoing cooperation was 9.4 years. All participating households were applying enclosures and housed animals on private land. The variety of years, practicing enclosures was spread from 3 to 29 years, and the mean was calculated to 11.6 years. In figure 8, the number of years with enclosures is categorized into four groups; 0-5 years, 6-10 years, 11-20 years and 21-30 years. The number of cattle, goats, sheep and all ruminants assembled is further presented in the proper category. A trend was seen that farmers who applied the enclosure system 21-30 years ago tend to have notably higher amount of animals in their livestock herds. This, in comparison to the ones starting the same practice later or more recently. The greatest difference was shown when comparing the categories 6-10 years to 21-30 years. Goats were shown to be the most common livestock animal among all categories, except from the category 6-10 years were goats slightly revealed the lowest quantity.

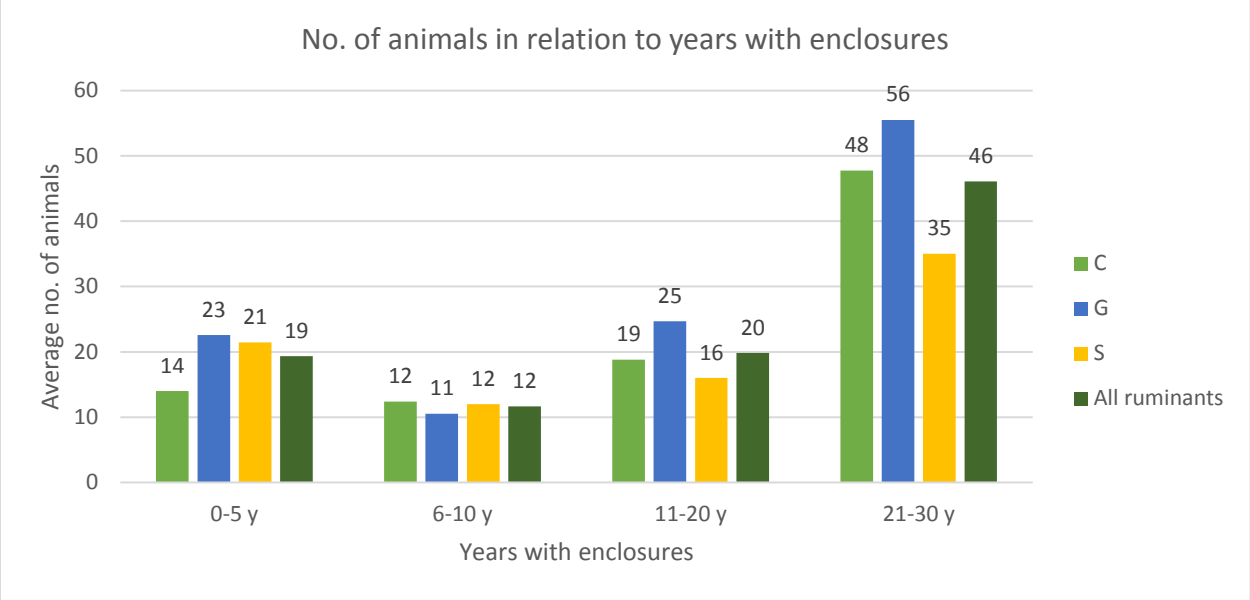

Figure 8: The diagram features the average number of C (cattle), G (goats) and S (sheep) distributed on four categories of the number of years applying enclosures. Young animals < 1 year is not included.

Although every farmer had enclosures for their livestock, as many as 33% still practiced free grazing as a complement and fed extra feed, primarily maize stover, every day during dryer periods. The main part of the farms had no water supply at home. Of those who had, the access was unreliable (figure 9). Animals without water available at the farm were herded to the river, stream or water hole every day (figure 9). Of the 23 farmers that had no water source at home, 15 gave their livestock water once a day, five twice a day, two more than twice a day, and one had free access at a passing river. During dry seasons the water source can be far away from the farm as the rivers are dry (figure 9).

Figure 9: Left: The communal water is unreliable. Upper right: Livestock herds at the water hole. Lower right: Dry river basin during dry period.

6.6. Animal livestock production

The purpose of the production was shown to be both for selling and self-consumption. The products that the participating farmers were producing were: milk, meat, live animals, eggs, chicken, manure, and hides. New born males were primary housed to get mature and gain weight for further sales when money was needed, as an economical security. When selling, the purpose was predominant to pay for school fees, as education was notably considered of great importance.

Of the 28 farmers keeping sheep, 9 did not milk them at all. For cattle and goats, all lactating females got milked every day. In general, milking was made twice a day for cattle, and once a day for goats and sheep. Milking was done manually by the farmers, mainly into cups. The ordinary use of the measuring unit, "a cup", could differ in volume depending on what type and size of cup being used. Therefore, an average of daily milk yield (DMY) (table 6) was approximately estimated due to various methods and measurement tools. The milk left over, after providing the households, was sold. Primarily goat and sheep milk were for self-consumption, and as many as 20 farmers had enough cattle milk to sell at occasions.

Table 6: Daily milk yield (DMY, in litres) of cattle, goats, and sheep

	Cattle DMY (l) n=29	Goats DMY (l) n=22	Sheep DMY (l) n=14
Mean	2.8	0.7	0.6
Min.	0.5	0.2	0.2
Max.	6.0	1.5	1.5
Range	5.5	1.3	1.3

As for selling live animals and milk, the prices differed remarkably among farmers (table 7). This was according to what type, sex or breed of animal sold. Heifers and males tended to generate more money, as did animals crossed to improved breeds because of their larger bodies. Egg seemed to give the same income for all farmers.

Table 7: The price of cattle milk, egg and live animals given in KES

	Cattle milk (l) n=16	Cow and heifer n=21	Bull n=14	Goat and sheep n=25	Egg n=25	Rooster n=19	Chicken and hen n=21
Mean	42	29 810	47 143	4 270	10	603	357
Min.	15	12 500	20 000	2 500	10	350	200
Max.	83	60 000	100 000	8 000	12	1 000	600
Range	68	47 500	80 000	5 500	2	650	400

7. DISCUSSION

7.1. Herd structure

To tell the exact number of animals for each breed or crossbreed, occurring on each farm is nearly impossible. In the study area the exact number of animals is of minor importance, instead the combined size of the herd is primary (Makokha et al., 1999). Attempts were done to roughly count the number of animals on the farms, but all animals were not on the farm at every occasion for visit. It was also difficult to categorize characteristics of livestock animals in Chepareria by looking at the exterior only. As there are several phenotypes of local breeds and crossbreeds it is difficult to know the amount of genetic material of a certain breed that exist in one individual. As mentioned, no documentation is done and all data are kept in the personal memory, accurate recording of the production and blood samples to identify the genetic material are required to achieve reliable results.

7.2. Breeding strategies

As many as 67% of the participating farmers considered themselves planning their animal breeding. In comparison to long-term breeding programs, the breeding was only planned for the next or a few generations to come. This short-term breeding strategy is probably used because the purpose of the production is mainly for survival, and fast improvement is needed and desired. To be taken into account is the fact that planned breeding does not mean the same for all people. This field study showed that all female ruminants were kept in the production. Young males were mainly sold at the market when mature and reproductive males were bought to be kept in the herds for

approximately 2.5 years, which correspond to a study by Kosgey (2004). This indicates that a recognition to avoid inbreeding does exist in Chepareria. However, the genetical reasons for not keeping the same males for longer is likely to be unknown among the farmers due to low education levels and lack of knowledge (Payne and Hodges, 1997). People in the Chepareria Division do not yet control the breeding, according to genetic traits, by selection of animals for recruitment or by artificial insemination, which could be a reason for slow improvement of desired traits. The question of how to move further, when the effect of direct crossbreeding is utilized, have to be taken into consideration (Payne and Hodges, 1997). It is of big importance to keep record of the production and offspring data on the males to improve the performance. To breed the largest males only is not the solution. A large male, with preferred exterior, does not necessarily give female offspring with higher milk yield compared to a smaller male of the same breed.

The great decrease of Friesian females, from 2007 to 2010 (885,901 and 6,043, respectively) (DAD-IS, 2007) indicates a less than successful introduction of an exotic breed. The reason for this decrease could most possibly be due to the Friesians significant higher demand of feed and its specific characteristics not suited for the tropic areas and the heat (Mestawet et al., 2014), in comparison to the local breeds. This is probably why the Friesian has not spread over Kenya. This is reflected among the participating farms in this study where only three farmers housed crossbreds with Friesian. Payne and Hodges (1997) stated that the survival and performance of exotic breeds is low in tropical conditions. But, the performance of a low producing exotic breed often brings a higher yield of milk and meat than a local breed. This could be the motive for housing crossbreds and exotic breeds in Ywalateke and Pserum. The most popular crossing was from LPZ x S, 40% of the farms had this combination. This is likely to be considered as a favourable cross as both breeds are indigenous and therefore adapted and suited to the environmental conditions in Chepareria. However, an adequate use of crossbreeding and planning for further improvement is needed to preserve a genetic variation required for a long term sustainable production. Purebred selection programs for indigenous cattle can be applied to design the breeding programs according to the possibilities in the area.

To make the development of further animal production in Chepareria more sustainable, education programs in basics of genetics could be of advantage. In combination, simple ways of keeping record on performance in animal production is most likely necessary to make progress. In several developing countries, programs for keeping production records are available for smart phones. But, as the farmers in Ywalateke and Pserum have no electricity at home difficulties of charging their mobile phones can occur. To keep individual and community herd books could be a more reliable way to start the documentation.

7.3. Management

Enclosures have been proven to decrease the overgrazing and soil erosion in the area. The pressure on the same land area is reduced as animals are not allowed to graze the same paddock for longer periods, but instead being moved between several paddocks in order for the grass to grow back. This opens for a greater possibility to cultivate feed and food. As a result, the animal production may be improved due to increased access of feed, which can be presumed to have a positive effect on milk yield and growth. A sufficient supply of feed can also make it easier to cover the higher nutritional demands of exotic breeds and crossbreeds. Furthermore, it can be assumed that a lower

number of animals need to be housed to produce the same amount of products, because of enlarged yields. This also means less work for the farmers.

When comparing Grönvall's (2015) thesis to my carried out investigation, large differences in number of cattle housed on the farms were shown. The number of goats and sheep was nearly the same. Farmers who had been practicing enclosure systems for long, 12-24 years, had according to Grönvall (2015) in average 8 cattle. My study, done one year later at the same period of the year, showed a result of 48 cattle on average on farms practicing enclosure systems for 21-30 years, and 19 cattle on average on farms practicing enclosure systems for 11-20 years. Included in the results of my study was one farmer, who had been practicing enclosures for 21-30 years, housing 113 cattle. This higher number of cattle (113) certainly raised the average. Anyhow, the results of Grönvall (2015) and me, indicates that the number of cattle among the farmers had drastically increased from 2014 to 2015. The increase of cattle may have been affected by the current prices on the local market. It can also reflect that cattle were more valuable when I carried out this study, and the possibilities to supply animals with feed, even during dry periods, could have increased.

7.4. Livestock production

The results for DMY is not fully reliable as different measurement tools were used among the farms. Mainly, the unit "a cup" was used to measure the amount of milk. These cups could differ in size and therefore the volume could only be estimated approximately. For future documentation of DMY uniform measurement tools need to be used by all farmers to give more exact and scientifically reliable results. To accomplish this, a suggestion is to assist the farmers with equal measuring tools.

The performance of average DMY for cattle was shown to be higher in my study, than in Grönvall's (2015). Grönvall (2015) got an average DMY of 2.6 l when including crossbred cattle only. In my study no account was taken to the breed, both indigenous and crossbred cattle were included, but still a higher average DMY of 2.8 l was shown. For goats, an average of 0.7 l per day was found in my study, compared to Grönvall's (2015) lower average milk yield of 0.3 l per day. All indicates that the overall DMY has increased from 2014 to 2015. This could depend on improvement of management, like more reliable feed and water supply. It can also be reflections of a more advantageously year with less drought and more rainfall.

The prices of milk and live animals is to consider as one reason for the broadly spread use of crossbreeding. Simply, larger animals give better profit at the market. If knowledge about heritability of different traits as milk yield, fertility and growth could be spread, the favourable traits would change from being phenotypic to genetic. The pedigree, rather than the current exterior, would be of interest.

7.5. Comments on the study

It is difficult to execute this type of baseline surveys because several factors might affect the results.

- Language barriers might arise. The language can be limiting when performing interviews, especially when an interpreter is necessary to carry out the study. Misunderstandings could have appeared, not only between the interpellant (me) and the interpreter, but also between the interpreter and the respondent. At occasions when the interpreter was considered not needed, misconceptions between the other two active participants were possible.

- Knowledge barriers are further reasons of error. In this study, the knowledge of genetics differed between the person who compiled the questionnaire and the respondents. The local interpreter also did not possess much genetic knowledge and therefore questions had to be redesigned as the interview proceeded in occasions when questions were not understood. The answers could thereby be others than expected.

- The reliability of the respondents answering honestly have to be taken into account. During this field study it did not seem that people gave the answers they assumed we wanted to hear. Sometimes it was clear that the interpreter gave the answer he presumed the respondent would reply, without asking the question. At those occasions he was told to ask the participating farmer the question in order to get the answer from the respondent.

- The farms selected for the interviews can vary a lot in size and number of animals housed at the farm. Therefore, comparisons between just a few studies can be difficult as the result can differ widely.

- The fact that different measuring units were used among the farmers have to be considered when looking at the results of DMY. No farmer knew the exact volume of "a cup".

- Some results were excluded because a few farmers were not aware of the number of animals or did not house certain species.

- The transmission of data could be further reasons of error as the replies from semi-structured questions were combined into categories. Also replies given when structured questions were asked could be wrong, for example when the farmers were not aware of the exact number of animals and gave an approximate number.

7.6. Conclusions

The phenotypic and genetic characteristics of livestock in Ywalateke and Pserum are hard to identify. As for future plans of breeding in the area determination of breeds and genetic material of livestock is recommended. To accomplish this, blood or hair samples and more detailed research on livestock animals have to be done. In addition, the genetic variation is surely decreasing in the area due to increased use of unrestrained crossbreeding. Breeding programs and a moderate use of crossbreeding is necessary to retain several valuable traits of the pure indigenous breeds. When planning for future breeding, local environmental, infrastructural and economical aspects have to be taken into account.

No long-term breeding strategies are applied in Ywalateke or Pserum. To be able to improve future animal production, as higher milk yield and faster growth, education and training programs in basics of genetics and recording of the production is needed. More detailed investigations on the topic of this thesis have to be done, in Ywalateke and Pserum, for further conclusions.

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APPENDIX 1

Questionnaire

Name: …… ☐ Male ☐ Female

Age (years)…….

1a Education ☐ yes ☐ no

If yes, what? ……

1b Other job ☐ yes ☐ no

If yes, what? ……..

2 Are you/have you been cooperating with VI-agroforestry?

☐ yes ☐ no

If yes, for how long and when? .....

3 How many people are working on your farm? .....

Are all of these family members? ☐ yes ☐ no

Of all workers, how many are working with the animals? .....

4 How big is your farm (acres)?

…….acres

How much is cultivated land ……..acres/ha ☐ private ☐ communal tenure

Structure of the herds

5 How many animals do you have and what are they used for?

	Number of animals	***Milk***	***Meat***	***Hides***	***Wool/ fur***	***Egg***	***Transport***		
Dairy cattle									
Beef									
Goat									
Sheep									
Poultry									
Donkey									

6 How many animals do you have at a certain age?

	<1 year	*1 – 5 years*	*>5 years*	*?*
Dairy cattle				
Beef				
Goat				
Sheep				
Poultry				
Donkey				

7 How many animals do you have of each sex?

	Females	*Males*
Dairy cattle		
Beef		
Goat		
Sheep		
Poultry		
Donkey		

8 What breeds are your animals?

Dairy cattle: ……

Beef: ……

Goat: ……

Sheep: ……

Poultry: ……

Donkey: ……

Other: ……

Breeding

9 Do you plan your breeding?

☐ yes ☐ no

If yes, how? ……

10 Do you use crossbreeding?

☐ yes ☐ no

If yes, why? ……..

……

11 Do you use your own animals for replacement?

☐ yes ☐ no

If yes, how do you avoid inbreeding? (Own males, buy new males, AI?) ……

……

how long do you keep the same male in the herd? ……..

12 How do you choose the replacement animals?

……

13 When are new animals born?

☐ seasonally, when? …….. ☐ all over the year

☐ planned, when? ……..

14 Do you keep any recording of your animals, what kind? (no. born, ear tag, dead, yield, sex….?)

Dairy cattle …… Beef ……..

Goat …….. Sheep ……..

Poultry …….. Donkey ……..

Other …… Other ……..

Animal production

15 What is the purpose of your animal production?

☐ self-consumption ☐ sell

If sold; ☐ slaughter ☐ living animal

16 What products do you produce and do you sell those?

Product: …… ☐ yes ☐ no

Product: …… ☐ yes ☐ no

Product: …… ☐ yes ☐ no

Product: …… ☐ yes ☐ no

Product: …… ☐ yes ☐ no

17 Do you keep or sell the newborn?

☐ keep ☐ sell, at what age?……

Why keep or sell?……

18 How often do you milk the animals?

☐ 1/day ☐ 2/day ☐ less than 1/day ☐ other? ……

19 Do you keep any recording of the production?

Milk ☐ yes ☐ no how? ……..

Meat ☐ yes ☐ no how? ……..

Egg ☐ yes ☐ no how? ……

Other what? ……. how? ……

Other what? ……. how? ……

20 How and how much do you get paid for the products? (känslig fråga, Ben tydlig)

Milk, (kg/milk)? ……

Meat, (kg, LW, SW, assessment, animal)? ……..

Egg, (g, no)?

……

Pasture practices

21 Do you use enclosures?

☐ yes ☐ no

If yes;

since when? ……

why did you start? ……

how did you do before? ……

why do you think that not everyone is using enclosures? ……

any problems with cattle rustling? ☐ yes ☐ no

how do you avoid it?……

any problems with predators? ☐ yes ☐ no

how do you avoid it? ……..

22 Do you still use free pasture/grazing?

☐ yes ☐ no

23 Do you have more than one enclosure for your animals?

☐ yes ☐ no

If yes; how many? …… how big? ……

how many cows/area? …… how often are they moved?……

why do you move them? ……

24 What type of grass do you have in the enclosures?

☐ 1 year (anuelles) ☐ more than 1 year (perennes)

☐ sow ☐ self-grown

If sown;

☐ own seeds ☐ neighbor's seed ☐ bought, from where?.....

25 Do you feed any extra feed except from pasture?

☐ yes ☐ no

If yes, for what animals? .....

what kind of feed? .....

how often extra feed? .....

own produced/bought? .....

how much? .....

26 How often do the animals get water? Where?

.....

27 Stored water for the dry season?

☐ yes ☐ no

if yes; where/how do you store it? .....

28 Where do you keep your animals during the…

day? .....

night? .....

Health, diseases and predators

29 Do you keep any recoding of the health?

☐ yes ☐ no

if yes; how? .....

30 What is the most common health problem?

.....

how do you avoid it? .....

31 What disease can cause most damage?

.....

how do you avoid it? .....

32 Do you have problem with parasites?

☐ yes ☐ no

if yes; what parasites? ……..
how do you avoid them? ……

33 Do you deworm your animals?

☐ yes ☐ no

if yes; when? …….. how often? ……

34 Do you vaccinate your animals?

☐ yes ☐ no

if yes; against what? ……..

35 What is the most common cause of death?

……

36 Do you have any problems with predators?

☐ yes ☐ no

if yes; what kind of predators? ……

how do you avoid them? ……

Concluding questions

37 Do you want to continue with livestock production?

38 What are your plans for the future?

APPENDIX 2

Photographs of cattle - breeds and crossbreeds

Local Pokot Zebu








Sahiwal




Local Pokot Zebu/Sahiwal








Local Pokot Zebu/Ayrshire



Ayrshire/Sahiwal



Ayrshire/Friesian