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Abstract

Of all pastoralists in the world 42 % are living in Sub-Saharan Africa (SSA). West Pokot is situated in the North Western part of Kenya where 45% of the farmers are pastoralist, 29% are agro-pastoralists and 26% have mixed-farming. There is an ongoing change in the way of farming where pastoralist are settling down and starting to cultivate, so-called agro-pastoralists. The organization Vi Agroforestry has been helping farmers in several areas in West Pokot but mostly in the Chepareria area. The organization has been helping to introduce so called enclosures which is a fenced area were the farmer can cultivate and grow pasture. It is also used to keep animals out from an area, then called exlosure. Even by the use of enclosures, farmers find themselves having trouble to have enough feed during dry seasons. There is a gap in knowledge about nutritional compositions and management of these pastures and thereby how to get the best returns of their pasture. A total of 30 farmers were visited during a six week period where samples of enclosed pasture were taken. The 30 farms were divided into two different areas, Ywalateke and Psereum with 15 farms in each of the areas. Of these 15 farm five were selected by the local extension officers as being "the best" in each area and 10 were randomly chosen. The samples where then taken to Sweden and analyzed to determine Dry matter (DM), Energy, Crude protein (CP) Neutral detergent fiber (NDF) and Ash. Results showed no significant difference between the selected farms and the randomly chosen. However, there was a significant difference between the DM in the two areas ($p<0.001$) were the pastures in Pserum had significantly higher DM content and also in the content of CP were CP content in the pasture collected in the Ywalateke area was significantly ($p<0.05$) higher.

Sammanfattning

Av alla pastoralister i världen bor 42 % söder om Sahara. West Pokot ligger i nordvästra Kenya där 45 % av alla lantbrukare är pastoralister, 29 % är agro-pastoralister och 26 % har blandat lantbruk. För närvarande pågår en förändring i lantbruket där pastoralister nu bosätter sig och till viss del börjar odla mark, så kallad agro-pastoralister. Organisationen ”Vi-skogen” har hjälpt lantbrukare i fler områden i West Pokot och de har utfört mest arbete i områden omkring Chepareria. Vi-skogen har introducerat det som kallas enclosures vilket är ett stängslat område där lantbrukaren kan odla grödor och bete. Det används också för att hålla djur utanför ett visst område, då kallat exclosures. Trots detta har många lantbrukare problem med att producera tillräckligt med foder för att täcka behovet för hela året. Det saknas kunskap om näringsvärden i deras bete och också om hur man ska ta hand om dessa inhägnader för att få bästa avkastning. I den här studien besöktes totalt 30 lantbrukare under en sex veckor lång period. På varje gård samplades ett betesprov från en inhägnad. De 30 gårdarna var uppdelade på två områden, Ywalateke och Pserum med 15 gårdar i varje område. Av dessa 15 gårdar i ett område valdes fem gårdar ut (av lokala rådgivare) som ”de bästa” i området medan resterande 10 var slumpmässigt valda. Betesproverna togs till Sveriges lantbruksuniversitet (SLU) där de analyserade för bestämning av innehållet av torr substans (TS), energi, rå protein (RP), neutral detergent fiber (NDF) och aska. Resultaten visar att det inte fanns någon skillnad mellan de fem utvalda gårdarna och de tio slumpmässigt utvalda. Dock fanns en signifikant skillnad mellan provernas innehåll av TS ($p<0.001$) och RP ($p<0.05$) när man jämförde mellan de två områdena. Betesproverna från Pserum hade signifikant högre innehåll av TS än proverna från Ywalateke medan proverna från Ywalateke hade signifikant högre innehåll av RP än proverna från Pserum. För att kunna dra ytterligare slutsatser om betet i inhägnaderna måste en mer omfattande studie göras, under en längre tid som inkluderar fler gårdar.

1. Contents

1. Introduction

Kenya is situated in sub-Sahara Africa (SSA) on the equator at the eastern coast of Africa bordering to Tanzania, Uganda, Ethiopia and Somalia (FAO, 2015). In Kenya 48 % of the land is agriculture area and of this 19% is arable land (FAO stat, 2015). The total population of Kenya in 2014 was 45.5 million people and 75 % of those are depended on agriculture for their livelihood (TWB, 2015; FAO 2006). Pastoralism systems are commonly occurring in arid to semi-arid areas of Kenya and pastoralists inhabit large parts of the northern parts of the country and also the borderlands (Schrepfer & Caterina, 2014). Kenya has an area of approximately 584.000 km² where the largest part is semi-arid to arid land which is characterized by a low amount of rain that is also poorly distributed. Dryland areas are generally divided into four classifications; hyper-arid, arid, semi-arid and dry sub-humid (Hassan, Scholes and Ash, 2005). The annual rainfall in Kenya is between < 250 mm in the arid and semi-arid land to > 2000 mm in the high production areas. In areas where rainfall is low, the major challenge for farmers is to find enough food and water for their livestock during dry season. The low food supply for the livestock during dry season could result in both weight loss and starvation which makes the animals more vulnerable i.e. for diseases (Raikes, 1981). There are evidences that pastoralists of today are having a major crisis and droughts are often referred to as the only cause but factors such as ecological deterioration, population growth and adverse politic decisions are also factors affecting the pastoralists' livelihood (Makokha et al., 1999).

West Pokot is a district located in the north-west of Kenya along the border to Uganda (Makokha et al., 1999). The district is described as an area with severe land degradation with many gullies and little vegetation cover which is the result of population growth and overstocking of livestock. The Pokot people are described as people who put high value to their cattle, even when compared with other tribes in East Africa. The rainfall in West Pokot is often insufficient and this means that the pasture can only support the livestock during parts of the year (Östberg, 1988).

Vi Agroforestry (Vi-skogen) a Swedish Non-Governmental Organization (NGO) started to work in Kenya during 1983 with so-called agroforestry. In this system trees are planted to improve the soil structure and its ability to keep water and thus the growth of plants (Vi-skogen, 2015). Vi Agroforestry started to enclose pasture in the most degraded areas in Chepareria, West Pokot in order to stop gullies and prevent soil erosion. Before Vi agroforestry started working in West Pokot self-sufficiency for food was only possible during years with enough rainfall. With the initiative to enclose degraded areas and plant some trees, the start from systems with community grazing on communal land to grazing on private owned land was established. After some years, when pastoralists in the area saw benefits of enclosing, new enclosures were established without the involvement of Vi Agroforestry. Seasonal migration with the livestock was common before the introduction of enclosures. Migration is now less common in West Pokot and is mostly practiced by pastoralists with no enclosures, so called nomadic pastoralists (Makokha et al., 1999). Since migration is less common, the farmer now has to produce enough feed throughout the whole year and preferably of good quality. The knowledge about this way of farming is still lacking and it is important to find the best practice how to manage these pastures in order to improve the production and survival of the livestock in the area and by this improve the food security for the people. To know the nutritional value of the pasture is of great interest to managing the enclosures and to my knowledge no other studies has investigated the value of the pasture in this area.

The main objective of this field study was to investigate the quality of the pasture within enclosures in two areas of West Pokot; Pserum and Ywalateke. From indigenous knowledge it is said that Ywalateke is lusher due to more rainfall. Therefore, the difference in nutrient value between these two areas was of interest. The nutrient value of common supplementary feeds such as maize-hay and grass-hay was also investigated. Three hypotheses were tested:

- Pasture in Ywalateke has a significant higher nutritional value compared with pasture in Pserum
- The supplements grass-hay and Nephia grass shows higher nutritional value than the hay made from maize- haulm and residues (maize stover)
- The selected as “best farms” (based on the choice of the local extension officers) in the two areas have a higher nutrient value in the pasture compared to the randomly chosen farms

2. Literature Review

2.1 Pastoralists and their prerequisites

In Kenya almost 50% is dryland where pastoralism is the key agricultural production system. A pastoralist is defined as a person who derives more than 50 % of the income from livestock and livestock products and therefore their livelihood depends on the well-being of their livestock as well as the surrounding ecosystem (IFAD, 2015; Blench, 2001). Pastoralist can be found in many parts of the world and depending on the environment, climate and access to water the type of livestock varies i.e. reindeers, alpacas, cattle and small ruminants. What they all have in common is the mobility, the movement to satisfy the needs of their livestock regarding feed and water (IFAD, 2015; Blench, 2001). In some of the countries in SSA the pastoralist even represents the main proportion of the population. Of the worlds pastoralist 42% are living in SSA and as many as 25-50% of pastoralists/agro-pastoralists in Africa are estimated to live in extreme poverty (Rass, 2006; Schrepfer & Caterina, 2014). Agro-pastoralists can be described as pastoralists who have settled down and cultivate land areas but their subsistence can also be livestock based with very little focus on cultivation (Blench, 2001). Of the farmers in West Pokot 45% are pastoralist, 29% are agro-pastoralists (mainly livestock based) and 26% have mixed-farming. The population in West Pokot were, in 2009, 512 690 and there is an estimation of a population growth of 3.1 % annually. Of the population, 90% are working directly or indirectly with farming (Akoyo & Songok, 2012).

The pastoralists in Kenya have different breeds of cattle but the most common is the indigenous breed shorthorn zebu type. The Sahiwal breed has also been accepted as an indigenous breed but is originally from India and Persia and has been imported to Kenya (Rege et al., 2001). The shorthorn zebu has a body weight between 200-350 kg depending on sex (AGTR, 2001). The main type of livestock in West Pokot are cattle, goats, sheep, donkeys and chicken. The herd size varies and a household has between 2 and 20 cattle. Traditional zebu is the most common breed among cattle in West Pokot but improved milking breeds such as Holstein Fresian and Ayrshire can also be found (Makokha et al. 1999; ASDSP, 2015). The breed Sahiwal is also used to improve the local zebu in this area (Grönvall, 2015). The Sahiwal is a dual purpose breed and is thus used for both meat and milk (Nafis, 2015). Goat, Sheep and Cattle, especially Zebus, are all selective feeders and only eat the species they find the most tasty (Raikes, 1981).

Kenya has a varied landscape with the plain near the Indian Ocean shore, the inland plateau regions and several mountains. Even though Kenya is located across the equator the rain falling during the year is considered low and the amount also varies greatly between years (BBC, 2012). Due to a reduced ambient temperature with increasing altitude, the temperature in Kenya is subtropical or temperate, except in the lowlands of the coast which experience the constant high temperature associated with the latitude of the equator. There are two rainy seasons in Kenya; one between March and May and the second between November and December (BBC, 2012). The average rainfall in Chepareria is approximately 1200 mm a year, see figure 1. Because of the periodic drought with inadequate feed and water the farmers in West Pokot are facing major problems with low livestock productivity (Akoyo & Songok, 2012). Due to uneven distribution of rain, the pasture also changes in botanical composition, quantity and quality throughout the year. After and during the rain-season there is plenty of pasture but during the dry-season the pasture becomes scarce (Rutagwenda & Wanyoike, 1992).

According to the Kenya metrological department, the rainfall in West Pokot was normal with a tendency to above normal in 2015. The onset of the raining period started at the second to third week of October and stop in the end of December (2015).

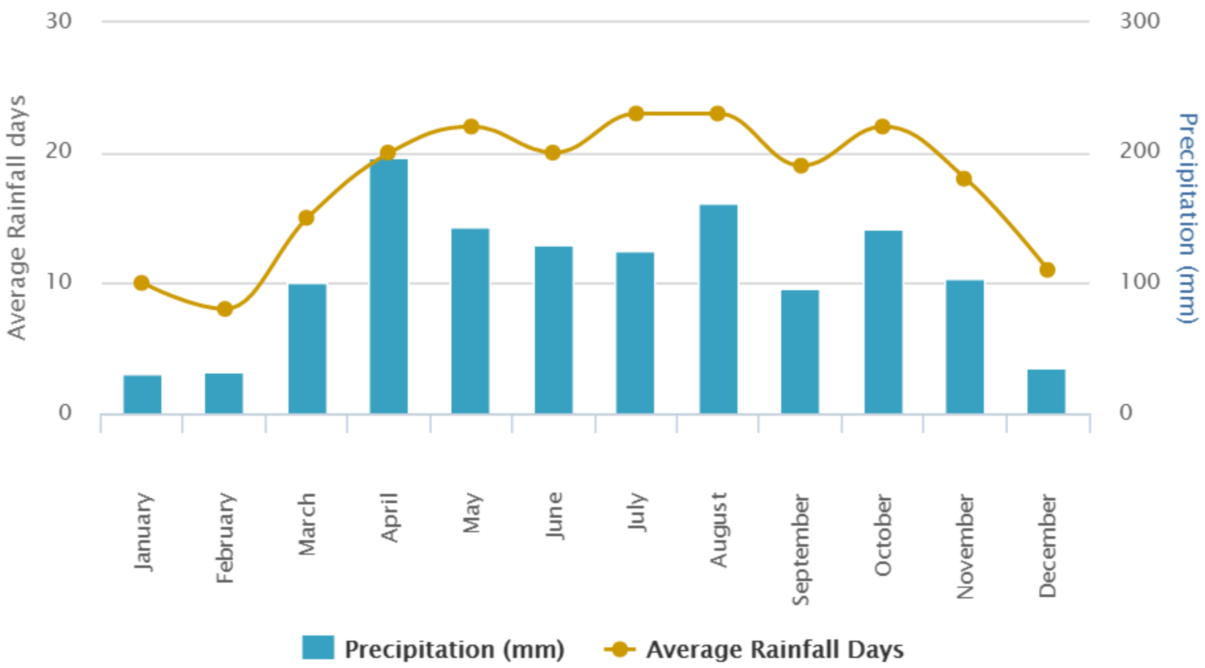


Figure 1. Average rainfall in Chepareria during years 2000-2012, West Pokot Kenya (WWO, 2015)

2.2 Enclosures

The use of enclosure systems in West Pokot reaches from before the colonial period where thorny branches as today were used for fencing in crops, see figure 1. During the colonial era, grazing regulations were initiated and the livestock were supposed to graze in different areas during different times throughout the year. Group ranches were also introduced during the colonial era but were disliked by the people of Pokot, mostly because it disrupted the old way of handling the livestock and also because it led to overcrowding of animals. During the peak of establishing enclosures in 1993-1995 many group ranches were dissolved and individual ownerships was desired for by the pastoralists in West Pokot (Makokha et al., 1999).

The use of enclosures has traditionally been for crop production and both live fencing such as euphorbia (*Euphorbiaceae*) or sisal (*Agave sisalana*) and thorny branches are used to keep animals out (so called exclosures), se figure 1. Farmers also have enclosures for grazing regimes which were established later but is now common (Wairore et al., 2015; Makokha et al., 1999). Enclosures can be divided into three categories depending in what way they were established in the Chepareria area: enclosures sponsored by Vi-agroforestry (10%), enclosures only assisted by Vi-agroforestry (16.5%) and enclosures not assisted by Vi-agroforestry (73.5%). Of the last category, 10% were established prior to the intervention of land use management by Vi-agroforestry in 1987 (Wairore et al., 2015).

Figure 1. Photo of an enclosure with fences made by thorny branches in Pserum (Photo by Freja Engström, 2015)

The enclosing system is also used in other countries in SSA, for example Somalia and Ethiopia (Gaani, 2002; Kenee, 2008). In Somalia there is a diversity of opinion about this way of managing the land. The fodder produced in enclosures represent the majority from where the animals receives their feed and therefor without the enclosures the trade of animals cannot continue due to the need of fodder produced. On the other hand, if the enclosures are kept and keeps expanding the traditional pastoral system, with migration as part of the livestock management, cannot develop or survive when access to large parts of the land is denied (Gaani, 2002). The same problem has been observed in Ethiopia where pastoralist tend to have less land to use. In Ethiopia production and selling of fodder from enclosures has become a widely known way to make a living (Kenee, 2008).

In the Chepareria area (in West Pokot) enclosures are mostly used by agro-pastoralists with a livestock-based production (78.3%) while the enclosures for agro-pastoralists with a crop-based production only accounts for 21.7% (Wairore et al., 2015). To enclose has become the dominant form of land management in the Chepareria area (Wairore et al., 2015). The use of enclosures in the Chepareria area has been observed to have benefits, such as; increased amount of feed for livestock, increased livestock production and higher value of land. Most farmers do feel that the benefits of the enclosure overcomes the hard work of establishing it (Kitalyi et al., 2002).

2.3 Grazing Systems

Agro-pastoralists in the tropics have established different herding practices for their grasslands. One system is where the livestock graze in pastures close to the homestead during the day and are taken back during nighttime. Another system is where all or nearly all animals are moved to rangelands further away from the homestead which provides seasonally better pasture. The third herding practice is similar to the second but here some of the animals always stay at the homestead and the other major part are moved to a place further away for a longer time and therefore it is more similar to the nomadic way of herding (Brandström, Hultin & Lindström, 1979). In areas with a high human population, grazing is used to a lesser extent than areas with low population density due to the lower area of land available for livestock. Instead the zero-grazing strategy has replaced the traditional feeding strategy. With this production system planted fodder such as Napier grass is used more frequently. Where population rate is low, grazing together with crop residues such as maize is the most common fodder source (Romney et al., 2004).

According to Benjamin Lokorwa at the Triple L[1] the farmers in the Chepareria area has established different types of grazing strategies and these are used depending on how many enclosures a farmer has. With one enclosure system the farmers keep their animals in the same paddock all year round which could lead to degraded feed supply. The other strategy is a multiple enclosure system where the farmer is able to use rotational grazing and prevent overgrazing. To maintain a good pasture requires complex management and different parameters such as number of livestock, what type of livestock and season must be included in the calculations. During heavy drought farmers in the Chepareria area can be forced to migrate their livestock to Uganda (Makokha et al., 1999).

2.4 Pasture and typical plant species on pasture

Of the world's grassland, 68% is located in developing countries and 800 million people are depended on it for their livelihood. Even though there are many people depending on it the knowledge about managing it in a sustainable way is often lacking. Managing of tropical pasture is known to be difficult and an understanding of the interaction between animals and herbage is needed due to the limitations the pasture can have on animals performance (Boval & Dixon, 2012; Reynolds, 2005).There are more than 500 species of Poaceae (commonly known as grass) in Kenya. The most common type of grass is the C_3 grass type which comprises 85% of all the plant species. At lower altitudes in Kenya, almost all grass species is of C_4 type, so called tropical grass. The C_4 type has its growth period during the warm season and requires higher temperature and more light than the C_3 type. The C_4 has a lower feed quality but a higher production rate. In the open grassland of Kenya no C_3 species were found below 2000 m and no C_4 species were found above 3000 m **(**Bareja**,** 2014; NSW, 2015; Tieszen et al., 1979). The C_3 species which are suitable and used in temperate areas are commonly considered to have a higher nutritional value than C_4 species (Barbehenn et al., 2004). In Kenya at altitudes of 1,800-3000 m above sea level and with an average rainfall of 1200 mm per year the species Kikuyu grass (*Pennisetum clandestinum)* and Star grass (*Cynodon dactylon)* are the most common in the natural grass cover, see figure 2 (FAO, 1985). Kikuyu- and Star grass are of C_4 species, see table 2 for chemical composition (Bell, Cullen & Echard, 2011; Yong-Ángel et al., 2012). For cattle to have a maximum bite size and bite rate the pasture has to be distributed in a way that makes is beneficial for the cattle. Dense pasture and relatively short (12-15 cm) swards allow the cattle maximum bite size. In many

[1] Oral Source from interviews with farmers from Chepareria in 2014

tropical areas, tall spindly plants are common which restricts the bite size of the cattle. (McDonald et al., 2011; Minson, 1990).

The digestible organic matter in dry matter (DOMD) varies with the cell wall content and components (Minson, 1990). The DOMD can be used to indicate how the pasture will affect the animals. In Australia, estimation has been done, where if the DOMD is between 70-80% the pasture is stated to be well suited for high production. Between 55-60%, only the dry livestock's maintenance can be met. Below 55% the dry livestock will lose weight (NSW, 2015). Dry matter content in pasture can vary where for example crude protein (CP) can range from 30g/kg in mature pasture to as much as 300g/kg in young grass. If the crude protein content in feed given to cattle is lower than 7% the microorganisms in the rumen can be affected negatively and therefore the feed intake could decrease (van Soest, 1994). When considering nutrient detergent fiber (NDF) it normally ranges from 275g/kg in young pasture to over 600g/kg in mature (McDonald et al., 2011). In a study performed in a semi-arid area of Uganda by Okello et al (2005) it was established that the nutrient value of pasture is dependent on both rainfall and temperature. In the same study, results showed that crude protein can be as high as 70 g/Kg DM after a rainy season and the NDF can be as high as 840g/Kg DM during dry-season. In the same study there was a significant difference in herbage yield and growth between seasons. The herbage grew mostly during rainy season and the yield peaked at the end of rain-season.

Due to an uneven amount of rainfall and shifting temperatures in areas with tropical grasslands, monitoring of pasture can be difficult. Even if the nutrient value of the same pasture is measured at the exact same time during two years the results can differ greatly (Ritchie & Anderson, 1998). Therefore understanding of vegetation structure and the dynamics of the system is needed and regular monitoring is needed to get a reliable result. The most accurate sampling technique is probably to measure the composition of the biomass. This technique is however site specific and the accuracy reduces when the environmental variation is high (ibid.)

To conserve feed is common and often conserved feed is offered in form of crop residues. However, to make hay from indigenous grass is also a common practice (Rege et al., 2001). When conserving feed such as hay, problems due to climate and weather can occur. In humid to sub-humid conditions the problems are often related to slower process of drying due to humidity (FAO, 2000). Napier grass, *Pennisetum purpureum,* has since the Ministry of agriculture in Kenya launched a scheme in 1984, become a common supplement feed for cattle and the chemical composition is presented in table 1 (FAO, 1985). Furthermore, when farmers have been asked to rank the best indigenous plant feed, maize is the most important among plant residues (Ndathi et al., 2012).

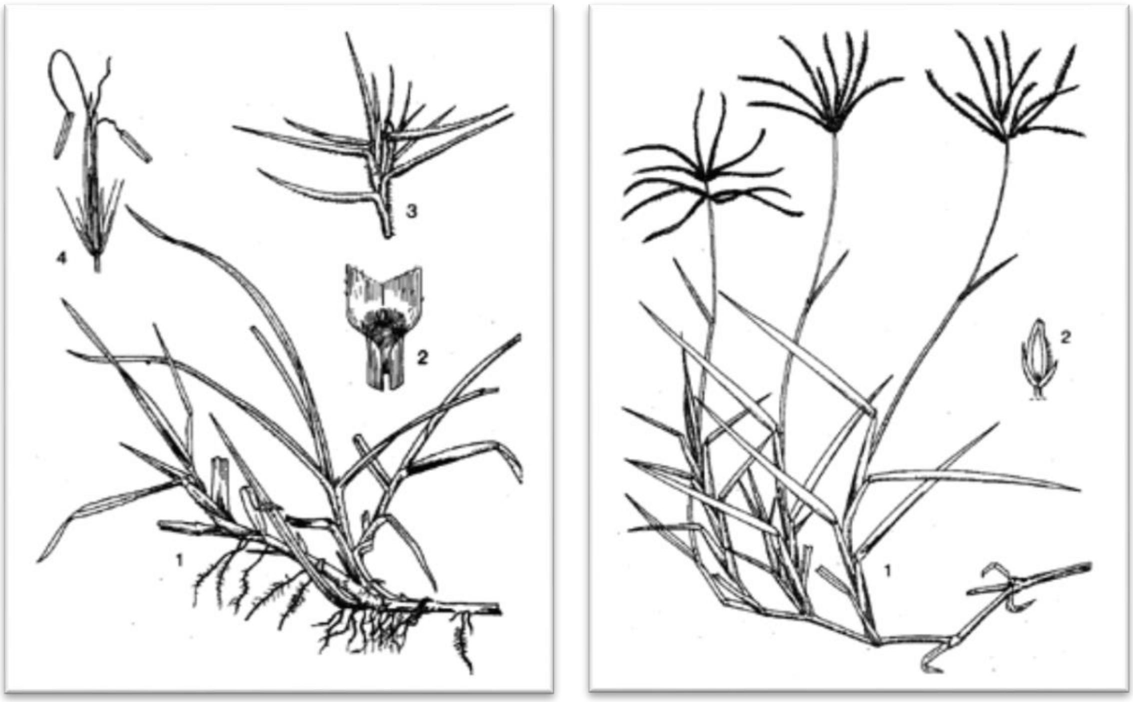


Figure 2. Star grass is shown to the left with the parts: 1 Flowering plant and 2 spikelet. To the right is Kikuyu grass shown with the parts: 1 habit of besal plant, 2 ligule, 3 inflorescence, 4 spikelet (TGS, 2011).

Table 1. *Typical nutritional composition of common grass species in Kenya (modified from Rangoma, 2012)*

Species	DM %	Digestible CP% of DM	ME (MJ/Kg)	Total digestible nutrient % of DM
Cynodon dactylon, Star grass (10-15 cm)	53	20.4	9.5	63
Pennisetum clandestinum, Kikuyu grass (Mature/dry)	17	6.5	9.5	63
Pennisetum purpureum, Napier grass (Mature)	35	-	8.9	59

2.5 Nutritional factors affecting the animals performance

Poor nutrition is the main problem affecting livestock productivity in the tropics. This is generally seen as reduced live weight, low productivity, higher age at first parturition, increased parturition intervals and high mortality (Rege et al., 2001). Digestibility and intake of C_4-grass type at an early maturity stage is low when compared with C_3-grass type (Minson, 2000). However differences has also been seen in voluntary intake and digestibility when giving all animals' tropical grass consumed in pen-stalls or grazed as pasture. In a study by Archimede et al, (2000) it was established that digestibility and voluntary intake decreased with age of grass when feeding animals tropical grass harvested at 4 to 6 weeks in pen stalls.

When animals instead were grazing tropical feed a similar decrease could be seen in digestibility with age of grass but the voluntarily intake was increased with age of grass, see figure 3. This could be explained due to tropical grass having a low sward density when young which limits the bite mass of the animal. When the grass is older and thus more mature the grass is higher and therefor gives the animal bigger bite mass and a higher feed intake even though the digestibility is lower. When the feed is stall fed the animals can take as big bites as pleased and therefore the intake is higher when digestibility is higher (Boval et al, 2007).

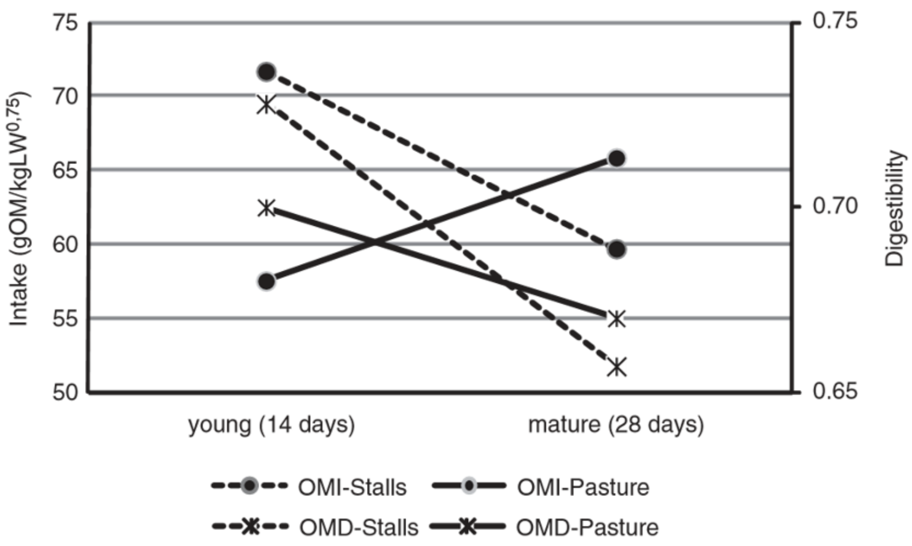


Figure 3. Shows the difference in tropical grass being pen-fed or grazed, organic matter intake, Organic matter intake (OMI), digetability (OMD) (dotted line, Archimede et al, 2000) or grazed (solid line, Boval et al, 2007) (Composed by: Boval and Dixon, 2012)

During degradation of feed in the rumen, volatile fatty acids propionate, acetate and butyrate are formed. By signals sent from the liver to the hypothalamus the volatile fatty acids reduces feed intake. When comparing these three volatile fatty acids, propionate and acetate has higher impact on feed intake than butyrate. When cattle are fed mainly roughage the volatile fatty acids have less effect on feed intake. This could be explained due to stretch and tension receptors in the rumen wall which will send the signal “full” to the brain (McDonald et al, 2011).

Neutral detergent fiber is the primary chemical component in feed which determines the degree of its digestibility. The cell contents are highly digestible while the digestibility of the cell-wall depends on amount of lignin. One technique of measuring cell wall content is NDF and the more NDF there is the less degradable the feed is. Feed that has the same digestibility but differs in NDF content will therefor stimulate different feed intake. The physical and chemical form of the cell wall will also affect digestion and intake rate, where for example the cell walls in leaves are more easily broken down than stems with the same digestibility. As the plant matures, part of the NDF becomes lignified making it more difficult to digest and digestibility will decrease. When comparing tropical grass with their temperate counterparts the tropical grass is in general less digestive. This is due to their leaves higher content of vascular bundle and thus more lignin (McDonald et al., 2011; Minson, 1990).

The most common limiting nutrient factor for cattle is energy (Philips, 2010). The net energy requirements for maintenance for a zebu 0.474MJ/LW$^{0.75}$ (Cardenas-Medina et al., 2010; Marcondes et al, 2010). For cattle in Sweden this is estimated to 0.507 MJ/LW$^{0.75}$ (Spörndly, 2003). The metabolizable protein and net protein requirements for zebu is the same as for the dairy breeds (Bras, 2005). The main source of energy in cattle diets is carbohydrates. The protein consumed is manly to supply the protein requirements. Fat is a good energy source but cannot be used in greater extent than 7% of the totally diet due to the negative effect it has on the microbe flora in the rumen (Philips, 2010). In lean animals the metabolic body weight per unit intake tends to be higher. This could be seen in animals which are frequently short of feed where these animals seem to be constructed of bones and skin surrounding a large rumen (McDonald et al., 2011).

During onset of lactation the feed intake will increase and in the early lactation the cow loses weight. This is compensated for during late lactation when milk yield is decreasing and the demand of dry matter remains high (McDonald et al., 2011; Philips, 2011). The feed intake will also affect the growth of the cattle and an addition in feed should be made for animals in growing phase were for example younger animals need a more energy dense fodder (Spörndly, 2003).

3. Material and Method

The study was performed as a Minor Field Study in West Pokot, Kenya, in collaboration with the Vi-Agroforestry in Kitale and a research initiative called Triple L. Pasture samples were collected during September to October and brought to Sweden and analyzed in the laboratory at SLU. The initiative “Triple L- *Land, Livestock and Livelihood*” are conducting research in the area with the aim to understand, analyze and learn from the development and transformation of land use in West Pokot (Triple L, 2015).

3.1 The area of the field study

The study was carried out in two areas, Ywalateke and Pserum, both located in Chepareria Division that is one of six administrative divisions in West Pokot, see figure 4 (Makokha et al, 1999). Previous studies has been done in the two areas and they were therefore chosen to extend the knowledge of the pastoralist systems. The areas where the study was performed was on an altitude between 1700-1900m. West Pokot County covers 9.100m^2 and is located in the North West of Kenya and it consists of semi-arid to arid land (Makokha et al., 1999; FAO, 2006). In Chepareria the lowest rainfall occur between December to March with an average rainfall of 32.5 mm per month, next to that is September the driest month with 95.2 mm of rain on average (WWO, 2015).

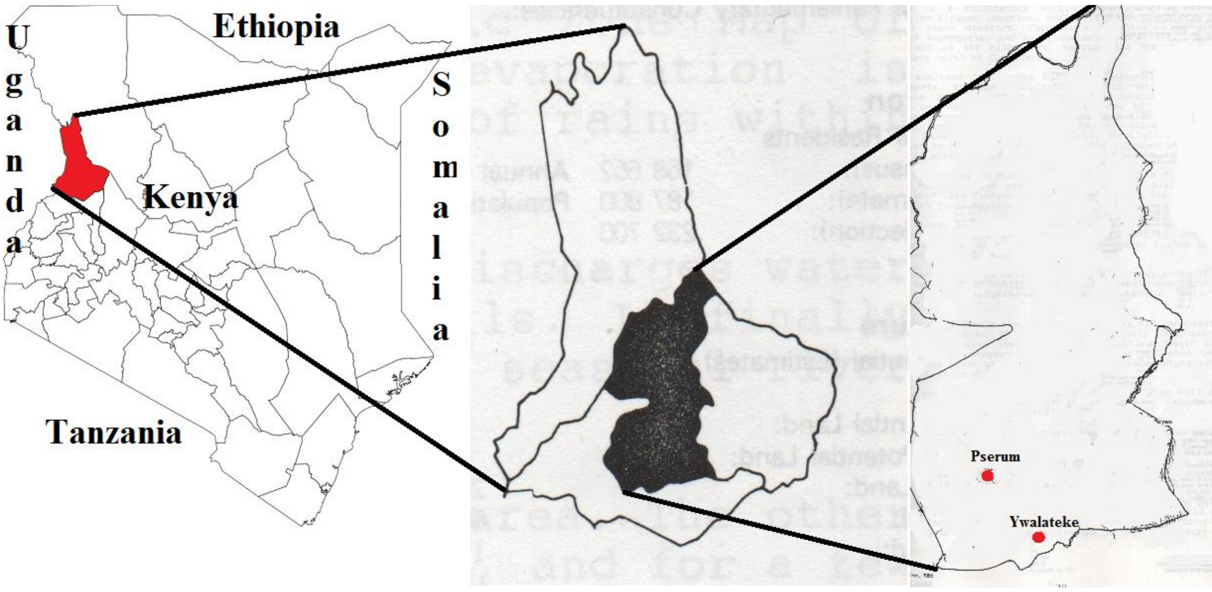


Figure 4. Map to the left shows location of West Pokot County in Kenya (Mapsof, 2016). Map in the middle shows study location in West Pokot (Östberg, 1988). Map to the right shows the two areas Pserum and Ywalateke (Östberg, 1988).

3.2 Data collection

3.2.1 Study farms

All farms using enclosures for their animals in the Chepareria area were compiled in a list. From that list five farms within Ywalateke and Pserum were selected because according to the five extension officers in the area these farms had from hearsay the best management practice on their farms. In addition to the five farms respectively in Ywalateke and Pserum selected as the ones with “best management”, ten farms in each area were randomly chosen from the same list. The total of 30 farms were visited for interviews and grass sampling during a total of 6 weeks.

A smaller questionnaire was conducted where a local interpreter, well known in the area, was used to translate from the local language Pokot to English and the following questions were asked:

- How many cows do you have?
- Do you feed any extra feed, if yes what and how often?
- Do you use communal grazing?
- Do you have more than one enclosure for your animals?
- How often do you move your animals?
- What type of grass do you have in your enclosure, self-grown or sown?
- Do you have your own water pipes or live close to water?

3.2.2 Pasture sampling

At each farm pasture samples were taken at one single occasion. If the farm had more than one enclosure for pasture, the enclosure not being grazed for longest time was selected for pasture sampling. The chosen enclosure were divided into 3 sections and in each section ten samples were taken randomly at every tenth step. The samples were taken by hand and each sample was grabbed between the thumb and the first finger. The sample was cut off with a pair of scissors at a length of 5 cm from the ground to imitate what the cattle would eat. The sample were collected in a paper bag and the weight was determined with a digital weighing scale immediately after picking. The aim was to collect between 200-300 g of pasture. If the pasture had little vegetation cover and the sample did not reach between that span (due to over grazing or drought) the sampling continued with randomly picking five times in each section until it reached at least 100 g. When this was the case it was noted. The size of the enclosures where samples were taken was measured by using a GPS (Garmin eTrex).

Only two of the farmers visited cultivated specific feed used as supplements for their animals. One of them had paddocks for hay making and one sample was collected from already made hay. One farmer also grow Napier grass as supplement feed for the cattle and one sample of this was also collected. Samples of maize residues were collected from one farm at each of the two areas since this were often given to their livestock as supplements. These samples of supplementary feeds were taken out of curiosity but due to the limited ability to transport these to Sweden only a few samples were taken.

The samples were dried outside in a temperature of ca 25-30°C and turned once a day until dry. The samples were dried in boxes with fine mash net in the bottom to help the drying. It was considered dry when the grass was easily broken. When dry, the samples were put back in the same bags and weighed again so the dry matter content could be determined but this was also done to prevent it from molding until analyzes could be performed.

The samples were then mixed and chopped in to smaller pieces by a pair of scissors and a smaller part of the sample was thereafter put in paper bags. The samples were kept in the bags during the transport to Sweden until analyses were done.

3.3 Analysis of pasture samples

The samples in this study were dried in three steps to determine the DM. The samples were weighed directly after picking and thereafter when it had been sun dried. This was the first step to establish the dry matter content. To determine that the drying was successfully done and to facilitate further analyzes the samples were dried one more time in a drying cabinet on lab for 24 h. The samples were then weighed again and thereafter milled into a powder with a miller (Hammarkvarn KAMAS Slagy 200). The grass powder was put in to small plastic containers marked so it could be recognized. The third and last step to determine the DM was to put the sample in a 103 °C degree oven for 16h .When the samples were taken from the 103 degree oven they were put in an exsiccator until cool, and thereafter weighed. Ash was determined by weighing the samples, then putting them in a 500 °C oven for 3h and thereafter into an exsickator and finally weighed again.

To measure metabolisable energy (ME) and the digestibility of the pasture, the samples were analyzed with the method rumen *in vitro* organic matter digestibility (IVOMD) (Lindgren, 1983; Lindgren, 1979). To measure NDF, analyzes described by Chai and Udén (1998) was used. The method was done with 100% detergent strength and both amylase and sodium sulphite. The nitrogen content was established by using the Kjeldahl method to derive the crude protein content. A 2020 Digestor and a 2400 Kjeltec Analyser Unit was used (NMKL, 1976).

3.4 Statistical analyses

The statistical analyses were done using ANOVA with the random/nested model in the Minitab system (Minitab 17.2.1 2015). The random/nested model was used since both chosen and random farms was included in the study. The energy-, protein- and fiber content in the collected pasture samples were compared between the two areas and also the five selected farms were compared with the random chosen within the same area. The digestible organic matter in dry matter (DOMD) was calculated in all the samples. This was done by first calculating the organic matter then multiplying this with the organic matter digestibility.

4. Results

4.1 Nutritional value of the feed

When comparing the chosen farms ("best management") with the randomly selected in each area there were no significant differences in DM, MJ, CP, NDF and Ash. There was a tendency (p=0.08) for the pasture at the chosen farms having a higher energy content than the randomly selected farms in Ywalateke. When comparing the total of 15 farms in one area with the 15 farms in the other areas no significant difference could be seen in NDF, MJ and ash. Farms in Pserum had significantly higher DM than Ywalateke (p<0.001), see table 2. In Ywalateke the pastures had significantly higher CP than the pastures in Pserum (p<0.05), when comparing all the samples in one area with all samples in the other. The pastures stage of development were at all the farms in both areas considered mature, so called standing hay. Thus, the pasture samples that were collected on different farms and in different regions were assumed to be comparable with regard to stage of development.

As shown in table 3, in three of six cases the preferable value of minimum/maximum values of the measured parameters were found in Ywalateke. Noticeable is that both the minimum and maximum value of NDF and MJ were found in Ywalateke, see table 2. The digestible organic matter in dry matter (DOMD) was calculated and the mean value for the 30 farms were 47.2%, the maximum value was 56.7% (Ywalateke random) and the lowest 30.8% (Ywalateke selected). Three of the farms had higher values than 55%.

Table 2. *Mean values ±SD of the chemical composition of the pasture at the 30 farms. Dry matter (DM), crude protein (CP), neutral detergent fiber (NDF), mega joule (MJ) and ash in the different farm categories and two different locations.*

Variable	Ywalateke Chosen, n=5	Ywalateke Random, n=10	Ywalateke (N=15)	Pserum Chosen, n=5	Pserum Random, n=10	Pserum (N=15)	All farms (N=30)
DM (%)	39.8±3.2	45.8±9.1	43.8^{a} ±8.0	60.1±10.0	57.3±6.7	58.2^{b} ± 7.7	51.0±10,7
CP % of DM	6.9±2.7	6.5±2.3	6.7^{a} ±2.4	4.4±1.1	5.0±1.3	4.8^{b} ±1.2	5.7±2.1
NDF % of DM	66.4±11.8	64.7±4.4	65.3±7.3	68.6±3.2	68.4±3.2	68.5±3.3	66.9+ -5.8
MJ/Kg DM	6.5±1.6	7.4±0.8	7.1±1.1	7.1±1.1	6.7±0.8	6.8±0.9	7.0±1.0
Ash % of DM	8.0±1.8	8.5±1.3	8.3±1.5	7.7±1.7	8.7±1.9	8.3±1.6	8.3±1.6

^{ab} Means within rows with a differing superscripts are significantly different (P<0.05).

Table 3. *Minimum and maximum values of DM, CP, NDF, MJ and ash in the pastures at the 30 farms in the two different areas Ywalateke and Pserum.*

	Minimum value	Maximum value
DM (%)	32.1 (Ywalateke)	66.9 (Pserum)
CP (% of DM)	3.3 (Pserum)*	11.5 (Ywalateke)
NDF (% of DM)	50.1 (Ywalateke)	81.3 (Ywalateke)
MJ/Kg DM	4.0 (Ywalateke)	8.7 (Ywalateke)
Ash (% of DM)	5.8 (Ywalateke)	13.9 (Pserum)

*Two farms measured the same value and both were located in Pserum.

The botanical composition was not investigated at the 30 farms but visual estimations from the pasture sampling showed that Star grass was more frequent occurring in the pastures than other species in both areas. For the supplementary feeds see figure 5, no statistical analyzes were conducted but the nutritional values are summarized in table 4.

Table 4. *Chemical composition of the samples taken of supplement feed. Hay and Napier grass were found in Ywalateke and the maize stover samples were taken from both areas.*

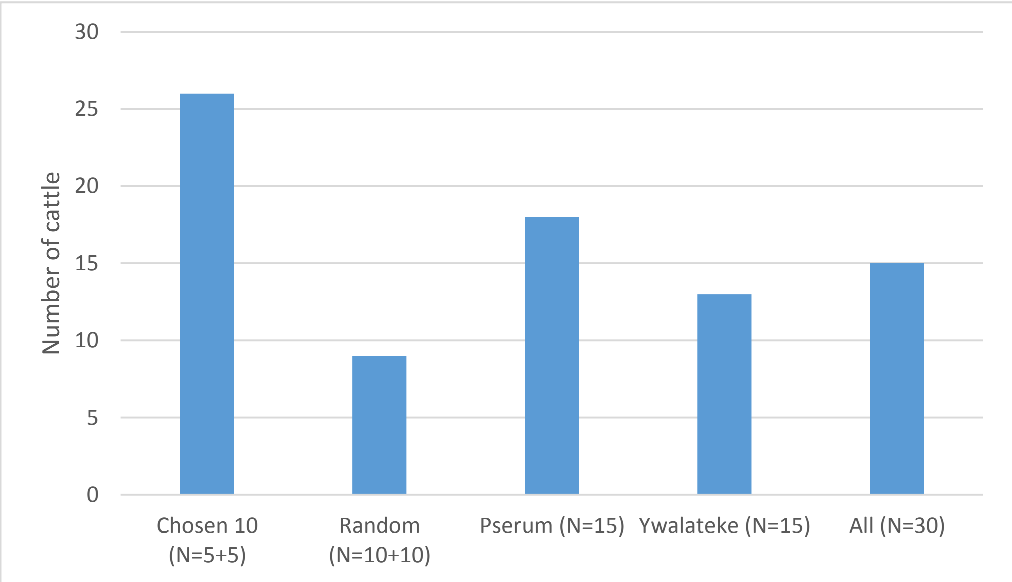
	Napier (one sample)	*Hay (one samples)*	*Maize stover (mean of two samples)*
DM (%)	26.8	75.6	88.9
CP % of DM	8.6	3.0	3.9
NDF % of DM	65.6	77.0	76.9
MJ/Kg DM	8.1	9.2	9.8
Ash % Of DM	11.5	7.7	6.1

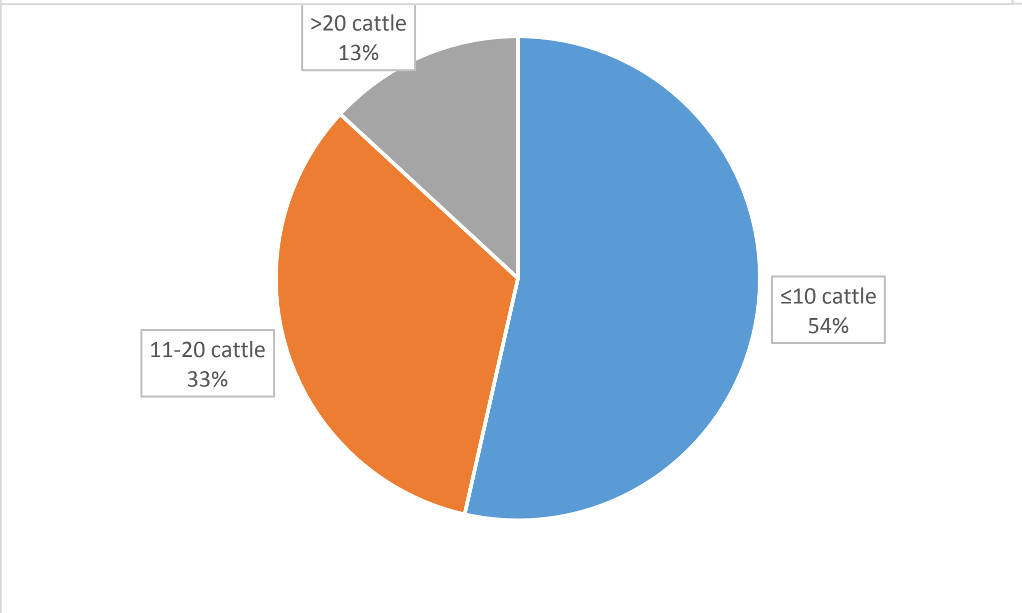
Figure 5. To the left shows one of the famers hay supply for dry-season. To the right is the supplementary feed Napier grass growing at a farm. (Ditte Löfqvist, 2015).

4.2 Farm Characteristics

In average the farmers had 15 cattle when calculating mean values including both areas. In Ywalateke the mean value was 13 cattle and in Pserum 18 cattle, see table 5. When divided into groups (see figure 6) most of the farmers, 53 % have ≤10 cattle. Ten farmers had between 11-20 cattle which is equivalent to 33%, only 13% of the farmers had >20 cattle, see table 5. One of the farmers in Pserum stands out with having 80 cattle. When comparing the chosen ten farms (5 in each area) with the random 20 farms (10 in each area) the number of cattle is 26 at the chosen farms and nine at the random. The farm with 80 cattle was one of the chosen farms and when excluding this farm from the calculation of mean number of animal at the chosen farms the mean decreases from 26 to 20.

Table 5. *Shows the average number of cattle of: the chosen ten farms, the random picked, in Pserum, in*





Ywalateke and the last column shows the average when including all of the farms.

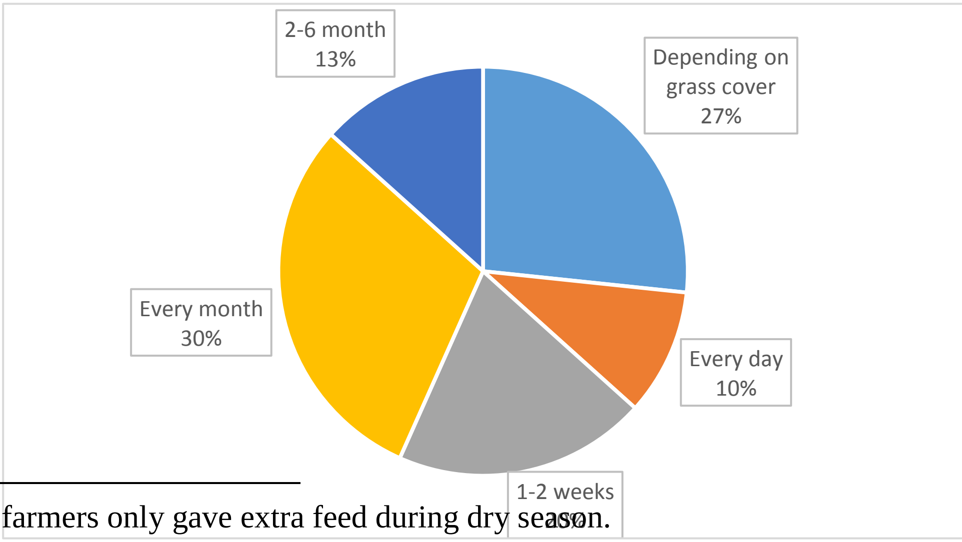
Figure 6. The average number of cattle per farm is presented in percentage by the categories ≤10 cattle, 11-20 cattle and >20 cattle.

Only 33% of the farmers used communal grazing (two of them only during dry season) which is grazing on public land without enclosures. Most of the farmers gave the cattle extra feed (77%). The most common supplementary feed was maize stover which was given at 87% of the farms. During the time of when the field study took place the farmers were just about to harvest their maize so the availability of maize stover at the farms visited were low, due to this and the limited possibility of space during transport of samples to Sweden just a couple of samples were taken. The farms using other fodder supplies gave hay, Napier grass and bean residues and they were all situated in Ywalateke. No restrictions were made for the supplementary feed, it was given to the whole herd. Most of the farmers lack available water on the farm (70%). All of the famers had natural pasture (Table 6).

Table 6. Percentage of farmers who used communal grazing and gave extra feed. Percentage of farms that had own water piped and the practice of sown pasture.

	Use of Free grazing	Own water pipes at farm	If extra feed is given	Sown pasture
Yes	33%[2]	30%	77%	0%
No	67%	70%	23%	100%

The farmers visited, had between 1-8 enclosures of varied size for their cattle. The enclosures were measured for size where the pasture samples were taken and were between 0.011-9.7 ha, this except for one who was not measured because of its big size and difficult terrain surrounding it. The average enclosure, when excluding the one too big to measure, was 2.3 ha. How often the animals were moved between the enclosures varied. Eight of the farmers said that it depended on the grass cover how often the animals were moved. Three of them said it was as often as every day, six moved them between every 1-2 weeks. Nine farmers moved them every month and four of the farmers moved them between every 2-6 month, (Figure, 7).



[2] Two farmers only gave extra feed during dry season.

Figure 7. Percentage of farmers which moves their animals to a new paddock after a certain time period.

5. Discussion

The results indicates that the nutritional value of the pasture did in general not differ neither between the two areas nor between the chosen farms ("best management") and the randomly chosen farms. Therefore the hearsay of the chosen farms having a general better management can be questioned. What did differ was the noticeable larger number of animals at the chosen farms compared with the randomly chosen, on average 26 and 9 respectively. When excluding the farm with 80 cattle the difference were still notable between the chosen and randomly chosen farms 20 to 9 on average. The nutrient value of the pastures varied among the farms visited. As energy is considered the most limiting factor for livestock this value is of great interest. The energy content ranged between 4.0-8.7MJ/Kg DM which is common in tropical pastures and can be compared with the energy content in straw made from barley and oat in high producing countries (Johansson, 2013; McDonald et al., 2011; Moss, 1993).

It was hypothesized that Ywalateke would have higher nutritional values, thus higher energy and protein values since this area is considered to have more rain. The DM and CP both had significant results when comparing between the two areas but in different ways. The DM were significant higher in Pserum whereas the CP were significant higher in Ywalateke. A lower DM on the pastures in Ywalateke compared with Pserum is interestingly in line with the indigenous knowledge of Ywalateke having a higher amount rainfall than Pserum. The DM can vary both between days and within a day but in this study the climate were close to constant with no rainfall during the study period and with a high temperature from early morning to evening. Therefore the significant difference between the two areas is considered an actual different and not a coincidence.

When considering the higher CP values in Ywalateke the mean value of the 15 farms in the area was 6.7 %. When relating this to what von Soest (1994) considers is a threshold value of when protein content effects feed intake, 7%, it cannot be considered a high value for protein even though it is higher than in Pserum. The CP results is however not uncommon for these areas, when Johansson (2013) visited ten farm during eleven months 50 % of them had a mean value of CP lower than 7% during these eleven months. The higher values in Ywalateke could be due to the higher amount of rainfall in the area which in turn gives more favorable conditions and therefore a higher amount of young grass and thus higher CP content. In a study performed by Okello et al., (2005) a tendency for correlations between amount of rainfall and CP could be seen ($p=0.10$). Even though no significant differences could be seen between Ywalateke and Pserum in the present study for NDF and MJ the numerical mean values differed. The NDF was in average lower and ME higher in Ywalateke which in both cases is considered desirable. In the study performed by Johansson (2013) it was observed that after a period of heavy rainfall the nutrition composition of the pasture changed which could be due to a higher amount of new grass started growing after the heavy rain. The NDF became lower and both ME and CP became higher which is comparable with the results from the pastures where Ywalateke is known to have higher rainfall than Pserum and therefore more results with higher nutritional values.

Because of the importance of energy supply an estimation of what a Pokot farmer has to produce could be of interest for future studies. During Swedish conditions the estimation of 0.507MJ/kg LW is made for cattle. In the two studies performed by Cardenas-Medina et al. (2010) and Marcondes et al. (2010) the estimation for zebus were 0.474MJ/kg $LW^{.75}$ and since zebus have according to AGTR (2001) an average weight of 300 kg that is equal to approximately 34 MJ/day. The average farmer had 15 cattle in Chepareria and therefore has to produce 512MJ/day and 187 070MJ/year to meet the maintenance need of his cattle.

The species of grass in the pasture were only visually estimated and star grass (*Cynodon dactylon)* was considered as the most common. However this is in line with the findings of FAO (1985) where star grass is one of two most common grass species in Kenya in areas with the altitude and yearly rainfall as in Chepareria. However, when comparing the nutrient compositions of star grass made by Rangoma (2012) with the mean values of the 30 pasture samples in the present study they do not match and in particular not in CP content where Rangoma found the average CP of 20.4 % of DM and the average CP of these 30 sample were 5.7 % of DM. A possible reason for the different values could be that the star grass in the present study were a different maturity stage than the one from Rangoma (2012).

From recommendations on DOMD from the NSW government (2015) only three of the 30 visited farms had values that ranged within the category where livestock maintenance can be met (55-60% DOMD) and the maximum value recoded was 56.7%. Even though this is just recommendations it gives an indication of the quality where 90% of the pastures cannot provide adequate feed for maintenance. It is however important to stress that this study was only performed during one month with one single sampling occasion which can only give a snapshot of the actual quality of the pastures in the area. As mentioned, September is one of the drier months (after the months Dec-March), and thereby this result cannot be used as a general guideline throughout the year. Nevertheless it gives an indication of what pasture the farmers in West Pokot has to live and work with, see figure 6 . Since it was dry in the areas there was not always a lot of pasture left. This complicates the credibility of the samples because the herbage left on the pasture could be something the cattle did not find palatable and therefore left. However it could also be something the cattle preferred but had not yet had the time to feed on.

Figure 6. To the left an indigenous Zebu cow in an enclosure located in Ywalateke with plenty of grass. To the right Cross-breed cows in an over-grazed enclosure located in Ywalateke (Photo by Ditte Löfqvist, 2015).

The second hypothesis was that the supplement feeds grass-hay and Napier grass would have a higher nutritional value than maize stover. However to be able to draw further conclusions about these supplement feeds a more extensive study has to be done with more analyzed samples and in this case the number of samples was too low (single sample of hay and Napier grass, respectively, and 2 samples of maize stover) for any conclusions to be drawn (Table 4) . Important to note is that the nutritional value of the supplementary feed will be affected due to when harvested. The nutritional composition of the growing feed changes over time and both the energy and protein content are highest when the herbage is young (Jansson et al, 2013).

The largest herd sizes were found in Pserum where the average farmer had 18 cattle, this compared with Ywalateke where the average her size were 13 cattle. Of the 30 farms most of the farmers (54%) had less than 10 animals. This study indicates that Ywalateke has more desirable values when considering the nutrient value of the pasture and the herd sizes could be connected with the nutritional value. On one hand, the area with the slightly better pasture should be able to house the largest number of animals. It could however be due to the lower grazing intensity that gives rise to a better composition of the pasture. On the other hand the pasture could then be overgrown if too few animals are grazing. If the pastures is overgrazed it could be, as mentioned above, only the plant species the cattle do not find palatable left, this since it was observed in a study by Dumont et al, (2007) performed in Europe that cattle are selective grazers and only select grass with high nutritional value. However it is unlikely that they are as selective when there is a shortage of feed**.**

It was hypnotized that the chosen farms due to the hearsay of better management would have a higher nutritional value in their pasture than the randomly chosen. As mentioned earlier the herd size on the chosen farms were noticeable higher than at the randomly chosen farms. However the nutritional value of the pasture on these farms were not significantly better.

That the larger herd size at the chosen farms is possible due to a higher frequency of communal grazing than at the random chosen farms is not likely. This because only 33% of all the 30 farmers uses communal grazing. Of the ten selected farms four uses this regime of grazing which corresponds to 40 % of the selected farms. As a comparison 6 of the remaining farms used communal grazing which is 30% of these farms. The difference between the occurrence of communal grazing in the two categories is 10% and viewing that the number of selected “better” farms was so small, it is difficult to draw any conclusions from this small difference. One single chosen farm more or less in the category of selected farmers using communal grazing would alter the percentage 10 % up or down making any conclusions very uncertain.

A possible explanation could be that the selected farmers have more and bigger enclosures than the random chosen and therefore they can supply their animals with enough feed. Another aspect is that the farmers with most animals also loses most animals during drought and that the distribution of which of these farms that has the most animals could be different if the farms instead were visited after the dry period.

6. Comments on study

This field study was performed in Kenya and the samples collected at rural pasture areas in West Pokot but all the analysis were conducted at SLU. This has to be noted since the tropical grass was analyzed with methods used for samples that are grown under Swedish conditions and collected in Sweden, both on lab and for the calculations. At the laboratory, the in vitro method VOS was used and in a study performed by Mbwile and Udén (1991) it was concluded that this method has the highest accuracy compared with in vitro true digestibility (IVTD) and in sacco true digestibility (ISTD). However, in the same study it was discussed that it is difficult to know which of the methods that will always be the superior one. It is possible that the VOS method is most suitable for homogenous samples due to the easy way of standardizing it and it is the method with fewest manipulations. The IVTD method could be more suitable for heterogeneous samples containing various plant families. This because of its better buffering capacity, medium composition and the higher number of live bacteria. When the VOS method was used on the tropical grass samples in the present study, the rumen liquid was taken from Swedish high producing cows, which probably differs from indigenous breeds in Kenya.

To use a local person as guide and translator can, as always when using a translator, have influenced the results. Of the 30 farms 10 of the interviewed farmers spoke English and 20 were translated from Pokot to English where information could have been lost or misinterpreted. In addition, neither the author nor translator has English as a mother tongue. The fact that the chosen farms were selected by persons can also affect the results where i.e. emotional relations might affected which farms that were chosen as the best ones.

7. Conclusion

The protein and energy content at the pastures of the 30 farms visited was in general low with a CP of 5.7 % and ME 7.0 MJ/kg DM and with an NDF of 66.9 %. Pasture in Ywalateke tended to have generally more desirable results with higher protein and lower DM than in Pserum. A more extensive study is needed which covers all the seasons, include more farms and also investigates the stage of development, the proportion of leaf/steam and the botanical composition of the pasture.

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