EVALUATION OF NUTRITIONAL VALUE OF FIELD LEGUMES USING RABBIT (*ORYCTALOGUS CUNNICULUS)* AS THE ANIMAL FOR BIOASSAY

BY

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DECLARATION

Declaration by the Student

I declare that this thesis is my original work and has not been presented to any institution for any award.

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Date:…….…..…….

Declaration by the supervisors

This work has been produced with our approval as the University supervisors

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DEDICATION

This thesis is dedicated to my wife Hellen C. Mutai and my children (Joyce C. Mutai, Mercy C. Mutai, Amos K. Mutai, Bethwel K. Mutai, Caleb K. Mutai) who assisted me in one way or another during the time of my thesis writing.

ABSTRACT

Tropical field legumes are currently used in the feeding of livestock, mainly as a source of protein. However their nutritional values have not been adequately evaluated by animal nutritionists. This experiment was carried out to determine the nutritional value of four field legumes using growing rabbits as the animal for bioassay. Thirty Newzealand White, one (1) month old rabbits were randomly placed in rabbit cages in pairs. The design was a CRD There were 5 treatments representing the legumes i.e. Lucerne, *Desmodium*, Vetch and Beans and a control of Rhodes grass hay and each treatment was replicated thrice. Feed and water was given *adlibitum.* From the five Feeds, samples were taken in duplicate for proximate analysis to evaluate their nutritive value in terms of DM, CP, CF, Mineral, NDF and ME (Kcal). Data on daily feed intake was used to assess the growth rate and feed conversion efficiency. Daily rectal temperatures were taken from the 2nd week of experiment. This was done randomly on three rabbits in each treatment for a period of 2 weeks, this was to monitor possible clinical signs of toxicity, especially hypothermia. At the end of the experiment, two rabbits from each treatment were sacrificed and their gastro-intestinal organs weighed and examined for any toxic effects of the legumes. Research design was a completely randomized design (CRD) and data was analysis using analysis of variance (ANOVA). The results demonstrated that beans had the highest CP of 28.98% while Vetch, *Desmodium* and Lucerne had % CP of 25.90, 21.05, and 20.66, respectively. However, rabbit fed on *Desmodium* had the best average daily gain (ADG) of 12.72gm, and feed conversion efficiency of 0.097. Toxicity was measured through comparison of rectal body temperature, ante-mortem and post mortem findings on the different feeds which revealed that rabbits fed on *Desmodium* had the least toxicity score while the beans had the highest. From these results it can be concluded that *Desmodium* is the best legume as a protein source and the least toxic for growing rabbits.

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ABBREVIATIONS AND ACRONYMS

ADG - Average daily gain

Alopecia – Loss of fur

ANOVA- Analysis of variance

Arrhythmia – Low pulse rate

Bradicardia- Low heart rate

CP- Crude Protein

Dermatitis- Inflammation of the skin

DM- Dry matter

E.E- Ether extract

F.C.E - Feed Conversion Efficiency

FAO- Food Agricultural Organization

Haematuria – Blood in urine

Hypothermia – Low body temperature

ILRI- International Livestock Research Institute

KALRO – Kenya Agricultural and Livestock Research Organization

NDF - Neutral Detergent fibre

PICA - Depraved appetite

SPSS- Statistical programme for scientific and social studies

Toxicity – Ability to produce toxins

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CHAPTER ONE

INTRODUCTION

The global food security is one of the biggest challenges of the 21st Century and demographic experts estimate the world needs food requirement increase of 50-70% to feed an additional 2 billion people by the year 2050, FAO, (2014).

The contributions made by the livestock enterprises all over the world are enormous both to the individual livestock keepers and national economies. Optimum animal protein intake by man is required for maximum physical and mental development.

It is estimated that 1.3 billion people in the world live below the poverty line and that world population will increase to 7.7 billion by the year 2020 and over 95% of the population increase will be in the developing world Kenya inclusive and the report stated that the challenges faced by the 3rd world countries in the provision of adequate food is the lack of knowledge in the indigenous forage germplasms in the area of livestock nutrition and lack of proper mitigation programs on the adverse effects of climate change which impacts negatively on global food production for man and livestock species. Unfortunately, the availability of forage is increasingly getting scarce both in the peri-urban and rural agriculture, Houndonougbo et; al. (2012). The quest for innovative, sustainable and efficient livestock feeding systems therefore remains a priority. Along with this, efforts should be made to reduce the over reliance of cereals based feeds which exacerbates the ever increasing human-animal nutritional conflict. Kebede et; al, (2008).

1.1 Legumes as source of protein for animals

This study was done to evaluate 4 common field legumes (Family *leguminosea)* namely the green leaf desmodium (*Desmodium intorturm*), lucern (*Medicago sativa),*

Common Vetch, (*Vicia-sativa*) and been plant (*Phaseolus vulgaris).* The legumes are generally known to be good sources of protein to livestock both ruminants and non-ruminants. The green leaf desmodium is a tropical perennial forage and is a climbing plant with roots, nodes, and terminal deep pink coloured flowers. It is known to be palatable to livestock and that it has more vegetative growth than the silver leaf desmodium *(Desmodium incanum*).

Lucerne legume is a multipurpose forage and can be used both for direct grazing usually under strip grazing or can be cut and conserved as hay or silage. Its major challenge, unlike desmodium is vulnerability to salinity, hence its establishment limitation in Kenya's varied agro-ecological zones.

The Common Vetch is an annual climbing legume with slender branched tap root and terminal tendrils that facilitate climbing on other plants. The leaves are coloured blue to purple and provides palatable forage and can be fed fresh or as hay or silage.

The bean plant is a multi-purpose feed for both man and livestock. It adapts well to most agro-ecological zones of Kenya and several varieties each suited to a particular agro-ecological zone.

In this study, the Rhodes grass (*Chloris – gayana)* was used as a control since it is the most used grass by rabbit farmers in the rural areas either green or in form of hay. It is a tufted perennial usually established by seeds or stolons and grows well in wide agro-ecological zones.

1.2 Statement of the problem

Fodder legumes are an important source of protein for livestock and the use of field legumes in livestock nutrition has not been fully exploited. However, the comparative nutritive value of tropical field legumes and feed conversion efficiency of fodder and

legume forages introduced into Kenya from Ethiopia by International, Livestock Research Institute (ILRI) have not been thoroughly studied. There is also luck of affordable protein feeds for ruminants and monogastric animals.

1.2.1 The Rabbits as an Animal for bioassay

Rabbits have been used extensively in biological and medical research, but limited data has been published as to their nutrient requirements. Cheeke, et; al, (2003). Also there is no information on the potential toxicities of field legumes which may be hindering growth and development of rabbits. There is a great need to provide nutritional information to rabbits farmers and food manufacturing industries. There is need to investigate field legumes for presence of anti-nutritional /toxic compounds, this is because such factors retards growth in rabbits and may eventually have fatal effects on rabbits and other livestock species.

1.3 Justification

There is need to evaluate the nutritional composition of field legumes to ensure that the legumes being fed to livestock have the requisite nutrients necessary for maintenance and optimal livestock productivity. The rabbit has high nutrients utilization efficiency due to its feeding behavior of caecotrophy and coprophagy that ensures maximum utilization of available nutrient in a feed. Currently there is very little information on nutrient composition and their feed conversion efficiency on legumes introduced to Kenya from Ethiopia by ILRI, i.e. lucerne, desmodium and vetch. This could be one of the reasons for poor growth performance in rabbits.

In this study, the rabbit (*Oryctalogus - cunniculus*) was used in the bio-assay experiment since it is a herbivore (monogastric mammal) almost resembling a ruminant in its digestive physiology, with front and hind gut digestion (caecal digestion) and also its ability to early detect and tolerate toxicity. Rabbits have been

used in toxicity experiments since they have the ability to early detect toxic compounds in feeds and are also able to tolerate such to a certain degree.

1.4 Objectives

1.4.1 General Objective

To evaluate the nutritional value and toxicity of field legumes using rabbit as the animal for bioassay

1.4.2 Specific Objectives

i. To determine the nutrient composition of *Desmodium*, Lucerne, Vetch and beans.
ii. To evaluate the feed intake, feed conversion efficiency and growth rate of growing rabbits fed on *Desmodium*, Lucerne, Vetch and beans.
iii. To investigate for any toxic effects of the legumes species on rabbits

1.4.3 Research Hypotheses

Objective 1

Ha; The nutrient composition is not the same for the 4 legumes

Ho; The nutrient composition is the same for the four legumes

Objective 2

Ha; The growth performance and feed conversion efficiency of growing rabbits is not the same for the 4 legumes.

Ho; The growth performance and feed conversion efficiency of growing rabbits is the same for the 4 legumes.

Objective 3

Ha; The legumes have toxic factors that would be harmful to the growing rabbits fed on the 4 field legumes.

Ho; There is no toxic factors in the four legumes that would be harmful to the growing rabbits fed on the 4 field legumes.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The research study aimed at evaluating the nutritive value of field legumes as protein sources and determining their potential toxicities, anti-nutritional factors or deficiencies when fed to growing rabbits used as the animal for bioassay. Recent research on the use of legumes on rabbits nutrition showed that rabbits fed on the legume leucaena diverstifolia, had better growth rates compared to those fed on non-leguminous forages and those fed on the green leaf desmodium, (*D. Intortum*) had moderate growth rates, Katunga (2015).

The author suggested that the cropping of improved legumes constitute an alternative to avoid long walks by rabbits keepers to collect fodder which is scarce in rural areas and of low nutrient composition. They recommended further studies to determine the constraints of adoption of forage crops by farmers which will help to improve forage production near the households and boost rabbits production.

Protein functions in the animal metabolism

Proteins in the animal body play the following roles:-

Growth and maintenance of tissues

Before cells can synthesize new protein, they must have all the nutritionally essential amino acids available simultaneously plus sufficient nitrogen in a suitable form to make any of the nutritionally non-essential amino acids required. Much of the new protein synthesized by cells is used for the maintenance of the structures of the cells. This is required because proteins are continually degraded and then synthesized in a process known as protein turnover. One way in which protein is lost from the body is

within the skins, hair (fur) and nails which are constantly shed from the body's surface.

Formation of essential body compounds

A wide variety of the compounds needed to keep the body working properly is protein or amino acids or they are derived from proteins or amino acids. Enzymes and hormones e.g. insulin, gastrin and growth hormones are some of the examples. The amino acid, tryptophan, serves as the precursor for the Vitamin, niacin and also for serotonin, a vital neurotransmitter that is involved in transmitting nerve signals from one nerve cell to another. If a diet is deficient in protein the synthesis of the most vital of these body compounds seems to take priority over the synthesis of less important protein such as those in skin and hair. Thus a deterioration in the condition of the skin and hair is one of the earliest signs of protein deficiency.

Transport of nutrients

Protein play and essential role in the transport of nutrients from the intestine across the intestinal wall to the blood and from the blood to the tissues of the body and across the membranes of the cell of the tissues. These transport and membrane – bound carriers proteins are usually specific to one nutrient e.g. retinol binding protein only binds to retinol (one form of vitamin A), others are lipoprotein transferring many different lipid molecules.

Regulation of water balance

Fluid in the body is distributed between two types of compartments i.e. the intracellular compartments (within each cell) and the extracellular compartment (outside of the cells).

The extracellular compartment is itself divided into the intercellular (between cells) and intravascular (within the blood vessels) compartment. These compartments are separated from one another by cell membranes and the distribution of fluid between them must be kept in balance and this balance is achieved by a complete network of control system involving both dissolved protein and dissolved ions (electrolytes) primarily sodium (Na+) and potassium (K+) ions. Protein molecules in the blood that are too large to pass out of the blood into the intercellular space exerts oncotic pressure i.e. drawing water from the intercellular space back into the blood; this is essentially just a form of osmosis in which water diffuses into the blood because of the higher concentration of proteins (and other large molecules) within the blood. A hydrostatic pressure pushing fluid in the opposite direction out of the blood and into the intercellular space is also always present because of the pumping action of the heart.

Maintenance of appropriate pH

Protein in the blood serves as buffer which are compounds that resists changes in pH values hence maintaining pH even if small amounts of acids or alkalis are added to them. **Boisen** (1997).

Defense and detoxification

The body's ability to fight off infection depends on it's immune system ability to produce antibodies which fights off infectious agents (antigens). Specific antibody is required for each specific antigen hence the body must produce an astonishing diversity of antibodies which involves a considerable amount of protein synthesis. This means that a healthy immune system depends on a good supply of the amino acid needed to synthesize new antibodies. Malnourished young children particularly

in developing countries are known to have a lowered resistance to infection which leaves them unable to fight off many infections. FAO (2014).

Bioassay Experiments

A bioassay experiment is a test method used in evaluating the response by a living animal or plant tissue to a food nutrient, medicine or the toxicity of chemical contaminants. In such experiments a certain number of individuals of a sensitive species are exposed to the food or contaminant source for a specific period to determine nutritional or the toxic effects. It was noticed that weight gain in rabbits fed on the, legume Leucaena diversifolia demonstrated significant increase in live weight gain and there was no detection of any symptom of intoxication during the trial with L. Diversifolia in spite of the mention of mimoxine toxin in this forage. Heinrits et; al. (2012), Kouomenioc et; al, (1991).

It was also observed that L. leucocephala efficiently replaced Lucerne hay from 15% to 75% inclusion in diets of growing rabbits, Egli (1988) and Scapinello et; al, (2000). In a rat bioassay experiment, the diet significantly changed the result of toxicity and carcinogenicity studies and adlibitum over feeding of excessive calories to sedentary adult rodents resulted in an early onset of adverse metabolic events, endocrine-disruptive degenerative diseases, and tumors that result in early morbidity and mortality. Kevin et; al, (1999). The total amount of food fed per animal per day is the critical factor affecting their physiology, health and longevity, Masoro (1996). The most important dietary factor acting as an endocrine disrupter in rats is excessive feed intake, Finch (1990).

Historically, the principal indicators for dietary adequacy have been reproductive performance and growth, and the scientific basis for nutritional recommendations for

growth and maintenance have been based on results from the growth curves of weanling rats as an indicator of optimal nutrition. Typically the maximum growth rate (body weight) is compared in young rapidly growing animals fed adlibitum diets with various concentrations of nutrients while keeping the concentrations of other nutrients constant for one-month or two month period, Baker et; al, (1986).

Investigations into the feeding of rabbits in traditional systems with improved forage legumes in South Kivu D. R. Congo recorded the following findings, Crude proteins varied from 15.3 to 28.7 % and the CP for *Desmodium intortum* was 22%, DM was 23.4%, NDF 64.1% and ADF 47.3%, Katunga et; al. (2014).

In another study, it was reported that *Desmodium intortum* had a relatively good palatability to rabbits and that palatability can be influenced by dry matter and the level of anti-nutritional factors e.g. tannins and hence the preference by the rabbits Bindelle et; al. (2007). This also agrees with the findings that crude fibre content, post digestive factors, and sensorial perception, and the previous experience with the feed affected digestibility, Osunga et; al (2008).

Another study concluded that determination of the constraints of adoption of forage crops by rabbit farmers will help to improve forage production and to improve rabbit production. Katunga (2014).

2.2 Toxicity investigation

In another study, rabbits feed on the legume leucania - leucocephala developed serious alopecia and produced reddish-brown urine (aematuria) except in rabbits on Desmodium feed. They also had very dark and tender liver except for Desmodium and Rhodes grass group of rabbits. Cheeke et; at, (1987).

Certain fodder trees and legumes e.g. Lucerne have been found to contain chemical substances called saponins which damage the cell membrane and increases membrane permeability causing haemolysis of red blood cells resulting in production of red urine (haematuria). Saponins also causes listlessness, anorexia, weight loss and gastro-enteritis. Kumar et al (1990).

The observed alopecia and dermatitis could be due to zinc deficiency in the legumes. Amye et; al (2010). Protein of most legumes are deficient in methionine amino acid needed for proper fur formation and this was an observed condition in rabbits feed on beans and vetch. Irvine (2015).

(a) Rectal temperature

Hypothermia can be defined as the point when the animals natural ability to regain or maintain a normal body temperature is lost.

Rabbits can be in danger of developing hypothermia once its temperature drops below 37.8C^{o} rectal temperature threshold. If this threshold is surpassed, the rabbits internal body mechanism will not be capable of producing sufficient internal heat to replace heat lost to the environment. In extreme cases, the external appendages especially the ears may cool to the point where freezing of the tissue occurs causing irreparable damage.

In several hypothermia, the breathing and heart rate may be slow and may be hard or difficult to detect, John W. Jones (1990). The body temperature of a rabbit can differ by several degrees between individuals and also by the time of day in a particular rabbit, and the normal temperature range falls between 38.3 C^{o} - 39.4 C^{o}. Langer Jan, (2001).

Several factors may contribute to animal poisoning and in a bioassay experiment, there is the requirement that a sensitive animal species ingest or be exposed to the toxic plant at an appropriate time. There are many indications of plant poisonings and usually the most obvious cases involve sudden onset of disease in a group of animals; or sudden death since many plant toxins results in an acute poisoning. To correctly and quickly diagnose plant poisoning is often extremely difficult and in many cases initial clinical signs are non-specific such as diarrhea and post mortem lesions may be absent and specialized veterinary toxicology laboratories maybe needed for testing plant toxins. Cheeke (1998).

(b) Toxic plants

Toxic compounds have been isolated from some plants and legumes and are known to cause neurotoxin symptoms e.g. low heart beat (bradycardia) or high heart beat (tachycardia) and also reduced pulse rate (arrhythmia). Bradycardia results in less blood being pumped especially to the body systems and parts which are distal to the heart, B. Puschner, (2008). This means regions e.g. anal region of the rabbit which is site for rectal temperature taking will receive less blood in circulation therefore hypothermia results because blood usually transport the metabolic heat throughout the animals' body system. Irvine. E. et; al (2015).

CHAPTER THREE

MATERIALS AND METHODS

3.1 Study site

This study was done at the Christian Intermediate Training Technology Centre (CITC) Kapsabet College, situated in Nandi County, and in Nandi Central District. It is bound by the Equator to the south and extends northwards to latitude $0^0$34'N. The Western boundary extends to longitude $34^0$45'E, while the Eastern boundary reaches Longitude 35^0 25'E. It covers an area of 2,884.22 sq km with temperatures ranging from 15C° to 26C° and rainfall of between 1,200mm and 2,000mm per annum.

The study involved field work i.e. establishment of Desmodium and beans forages on two plots measuring 20 x10 m in CITC College farm. Rhodes grass hay and Lucerne hay were sourced from local dealers but common vetch was collected from natural pastures. Laboratory analysis was conducted in Kenya Agricultural and Livestock Research Organization (KALRO), Naivasha.

Kapsabet

Nandi

County

Figure 3.1 Map showing the area of study

(Source : Google maps)

3.2 The legume forages used

3.2.1 Green Leaf Desmodium (*Desmodium intortum*)

(i) Description

Plate I : Green leaf desmodium (Desmodium intortum) near flowering stage (Source: Author, 2016)

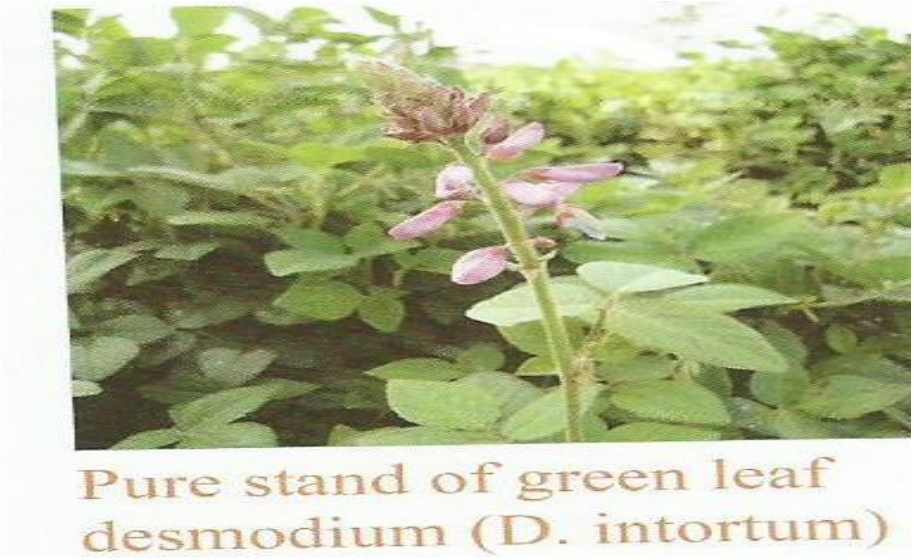


Plate 2: Mature green leaf desmodium at flowering stage

(Source: Author, 2016)

Green leaf desmodium (*Desmodium intortum*) is a perennial tropical forage leguminous plant; with long climbing stems with roots at the nodes. Stems can be

green or red. The plant has several trifoliates which are ovate, 2-7cm long and 1.5-5.5 cm wide and reddish- brown to purple in colour, with terminal flowers which are deep lilac to deep pink in colour. The pods are narrow, segmented, 5cm long and contain 8-12 kidney shaped seeds that adhere to hair or clothing. The seeds are about 3mm long x 1.5 mm wide. The Greenleaf desmodium has more vegetative growth than the silver leaf desmodium (*Desmodium uncinatum*) and has rounder leaflets and seeds that stick less strongly to hair or clothing Cook et; al, (2005); Skerman et; al, (1990), USDA, (2012).

(ii). **Defoliation**

Green leaf desmodium has high palatability and can be heavily grazed but will not withstand constant heavy grazing or frequent defoliation that removes the bud promoting sites. Cutting heights 7-15cm and initial grazing should be very light to permit establishment. However, under careful grazing management green leaf desmodium pastures rarely persist for over 6 yrs, Cook et; al. (2005).

iii) Utilization of desmodium.

Green leaf desmodium is usually used as a cut and carry (legume) and given fresh or as conserved dry hay or silage. The green leaf desmodium is selected for this research because it is versatile in its response to the various soil pH Conditions in the country, unlike the legume Lucerne which is very sensitive to acidic soils. Most rabbit farmers can therefore establish desmodium legume forage as a rabbit feed. Bayble et; al, (2007).

iv. Environmental impact

It is well known as a good cover crop, weed competitor and a soil enricher as a nitrogen fixing legume. It needs only 4months to cover the soil and prevent weeds from developing, ILRI, (2013) and has been used as a cover crop on coffee plantation in central Kenya, Maina et; al, (2006).

3.2.2 Lucerne (*Medicago sativa*)

Plate 3: Maturing Lucerne
(Source: Author, 2016)

Uses /applications

Lucerne was one of the first forage crops to be domesticated .It is used as multi-purpose forage, able to be used for both grazing and conservation (hay, silage). It can be sown as a pure stand (ley) or in mixtures with both temperate and tropical grasses.

Moisture

Lucerne is a crop which is relatively drought tolerant and will produce yields about in proportion to the water supply. In periods of drought will adjust plant density to cope with the availability of water supply. Its taproot is capable of following water supply

to considerable depths (up to 8 m, but more commonly 2-3 m). It is well suited to growing under irrigation.

Nutritive value

It is usually considered the **"**King of legume Fodders**"** because it grows throughout the year if soil moisture is available. Protein and calcium levels are high, relative to other fodders, but metabolizable energy (ME) and phosphorus levels are low. ME and phosphorus levels are good in young growth but drop rapidly as the foliage matures. Intake of digestible nutrients by livestock is higher than for most other forages. Level of fibrous tissues is low and this allows rapid passage through the rumen. Lucerne foliage is highly digestible.

Palatability/acceptability

Lucerne is highly palatable and there are some cultivar differences in palatability and this is thought to be the result of different protein fractionations.

Toxicity

Bloat is the major limitation to grazing Lucerne and a combination of management and control measures can be used to reduce the risk of animals bloating on Lucerne .Hungry animals are more at risk of bloat so provide animals with access to a source of roughage before or during grazing. There is usually reduced risk of bloat in mixed stands under rain grown conditions Access to anti-bloating agents (drenching, in their water supply, rumen capsules or sprayed on foliage) is essential in intensively grazed situations. Enterotoxaemia can be a problem with sheep and this can be controlled by vaccinations with sheep enterotoxaenia vaccine.

Animal production

When green feed is available, daily live weight gains for beef cattle will be around 0.7 kg/head/day compared weight 1kg/head/day on oats, improved tropical pasture and native pasture. This reduced weight gain is a result of the lower energy availability .However Lucerne grows throughout the year so, over the full year, supplementing native pasture with Lucerne can increase gains from 0.5 to 0.7 kg/head/day. Irrigated Lucerne can carry a beef cow and calf on 0.5 to 1ha on a year-round basis .Supplementing dairy cows grazing tropical grasses with Lucerne can raise milk production from 10-12 to 14-15 L/Cow/day. This can increase to 20 L/Cow/day if the cows are further supplemented with grain to combat the energy deficiency. Sheep numbers can be increased from 6 to 15 /ha by supplementing native pasture with Lucerne. Irrigated Lucerne can carry more than 80 dry sheep equivalents/ha.

Strengths

Year –round production, high quality, dual purpose (grazing or conservation), ability to extract water from deep soil layers, persistent, wide range of climate adaptation, responsive of irrigation.

Limitations

Low energy levels, restricted soil adaptation (fertile, well-drained); less acidic, cannot stand continuous grazing, causes bloat, susceptible to water logging. FAO (2010), KARI (2010).

3.2.4 Common vetch (*vicia sativa*)

Plate 4: Flowering Vetch (Vicia Sativa)
(Source: Author, 2016)

The common vetch (*Vicia sativa*) is an annual climbing legume with a slender branched taproot that can go deep to 1-1.5 m. The stems are thin angled and branched, reaching up to 2m and the leaves are compound with 3-8 pairs of opposite leaflets and 2-3 terminal tendrils that help in climbing. The flowers born on leaf axils are blue to purple and at times white and mostly paired. Pods are cylindrical 3.5 – 8cm long and erect and with black to brownish seeds. *Vicia sativa* provides palatable forage i.e. fresh, hay, and silage and grain to livestock. It also provides a valuable cover crop and green manure. FAO (2010).

Vicia sativa originated from southern Europe and is now widespread in the Mediterranean basin, west and central Asia, eastern china, India and USA. It is moderately tolerant to cold and can grow in areas with mild winters and in areas with annual rainfall of 310mm- 1630mm and on a wide variety of soils, with preference for well drained, moderately fertile soils with a PH of 6.0 – 7.0. It is not tolerant to drought during the early stages of establishment, but can with stand short periods of water logging but not extensive flooding. It is fairly tolerant to shade conditions and does well as a cover crop.

Forage establishment and management:-

Vicia sativa may be sown in pure stands or mixed with a cereal companion that helps it to climb and therefore prevents it from rotting.

DM Yields in pure stands or in mixed pasture range from 1-6 per ha. In the Mediterranean basin and up to 8 t/ha in U.S.A. Common vetch is tolerant to short cutting before flowering and of high cuttings at flowering.

Environmental impact.

Vicia sativa has a high ability to fix nitrogen provided that the seeds are inoculated with an adequate rhizobium strains or that it had been sown previously on the field, and it can provide nitrogen either to the cereals companion crop when sown in mixed pastures or to the following crop when sown alone. Crop residues are succulent and decompose quickly and are an appropriate green manure. It provides a moisture conserving mulch in strip tillage systems. It also helps with the suppression of spring weeds and is a valuable cover crop in vineyard and orchard, and weed suppression is increased when the legume is associated with a cereal companion crop. FAO (2010);

3.2.5 Bean (*phaseolus vulgaris* **)**

Plate 5: Maturing bean

(Source: Author, 2016)

Beans belong to several genera of the family *leguminosae* which are used for human and animal food unlike the closely related pea. Beans (*Phaseolus vulgaris*) are the most important legume stable food crop in Kenya and it rates second after Maize . World hectarage is 28 million Ha. Producing 40 million tones. Kenya's hectarage ranges between 300,000 Ha. to 500,000 Ha. Producing about 9,000 tonnes to 150,000 tonnes. It is grown in almost all areas in Kenya but the major provinces are Eastern, Central, Rift Valley, Nyanza and Western.

Economic Importance

Bean seed are the main source of proteins and vitamins. i.e. rich in amino acids, lysine, tryptophane, methionine, vitamin B, Nicotinic acid, calcium and iron making it a balance diet for rural poor who cannot afford animal protein. It is used in a variety of form to complement carbohydrates diets e.g. immature pods, mature seeds or dry beans. N-Fixation through root nodules of beans improve soil fertility status, and reduced amount of Nitrogen used in cultivation of beans and other bean/ intercrops (cereals). The leaves of beans can also be used as livestock forages.

Requirements

Rainfall:

Beans are not drought tolerant hence they require moist soil through the period. Rainfall of between 500 – 1500mm is ideal. Excessive rainfall during flowering causes flower drop and increased disease incidences. Medium rainfall is thus required during flowering and pod set. Dry weather is required during harvesting. The cultivars have more resistance to drought stress because they have capacity to continue flowering after stress. This capacity is also with delayed and uneven maturity e.g. Rose Coco variety Soils - grow on most soil types but must be free draining and fertile, with a pH of more than 5.5 and less than 8.

Temperature and altitude

In Kenya beans grow best in altitude above 600 m.a.s.l because below this, high temperatures causes flower and pod abscission causing poor fruit set and hence reduced yield. There are also high incidences of diseases like: bean rust, and bean anthracnose below this altitude. Altitude between 900-2100 is most suitable but can be grown up to 2700 m.a.s.l. as in case of maize. FAO (2010).

3.3 Rhodes grass (*Chloris gayana)*

Plate 6: Mature Rhode grass (Chloris gayana) (Source: Author, 2016)

Rhodes grass is a tufted perennial, usually stoloniferous (varies with genotype), with foliage from 0.5 -1.2 m, and fertile tillers from 0.9-2m tall .It is native to Kenya and many other Saharan Africa Countries. Found in open woodland and grassland, riverine and lake margins, and seasonally waterlogged plains, on a wide range of soils. It is excellent for making hay, but can also be grazed in the field .It can grow to 1.5m high in under good conditions. Rhodes grass can grow under wide range of rainfall (650-1200mm) and can persist under drought.

Uses: Rhodes grass is less suitable for the cut-and-carry system. It makes good hay if cut at or just before very early flowering. Generally not suitable for silage. Provides fair stand for roughage when mature, due to its greater cold resistance and lower loss of dry leaves and developed good ground cover. Stands develop quickly and can be grazed 4-6 months after planting, although highest production is reached in the second

year. Since feeding value declines rapidly with onset of flowering, it is important to maintain the stand in a leafy condition.

Establishment: Rhodes grass establishes well from seed sown at a rate of about 10kg per hectare. It also establishes well from root splits. It rapidly gives good groundcover under good conditions and can be propagated vegetatively or from seed. A more rapid cover can generally be obtained by planting from seed, usually at sowing rates of 0.5-1kg/ha. Seed matures 23-25 days after flowering. Mechanically harvested seed can contain a fair proportion of straw. Hand picking is satisfactory for small areas, and this seed needs minimal cleaning .Seed is locally available (Kenya Seed Company stockists, KARI, ADC farms).

Yield and nutritive value: DM yields generally range from about 10-25t/ha, depending on variety, soil fertility, environmental conditions, and cutting frequency. Yields in the second year may be double those of the establishment year, but this also depends on management and environmental conditions. Although *Chloris gayana* can survive on infertile soil. It is very unproductive, and may eventually die out, particularly if grazed regularly. Young growth is very palatable, but after the plants have seeded they are less attractive.

Animal production: Can carry about 1-4 beasts/ha depending on pasture productivity. Annual live weight gains of up to 160kg/head and 850kg/ha is achievable. Production declines without a vigorous legume or the use of fertilizer nitrogen.

Strengths

Widely adapted, easily established, high salt tolerance, tolerant of heavy grazing, few pests or diseases of economic importance, some varieties can suppress nematodes (e.g. C.V Katambora), good seed production.

Limitations

Short season of nutritive peak in many cultivars, fluffy seed difficult to sow, not adapted to acid, infertile soils, plants require high fertility to persist, low shade tolerance e.g. under another plant, Ouda J.O. (2001).

3.4 Rabbits

Rabbits (*oryctalogus-cunniculus*) as the animal for bioassay

Plate 7: New Zealand white rabbit

(Source: Author, 2016**)**

The rabbit (*oryctalogus-cunniculus*) is a pentadactyl herbivore and a monogastric mammal of the order lagomorpha and family leporidae, Sharkey, M.J. (1971). Rabbit keeping (Cunniculture) is amongst the latest livestock production enterprises referred to as "Emerging Livestock Enterprises".

In spite of these developments, rabbit production in Kenya is still under the youth and 4k club members and young farmers. Rabbit meat is second to ostrich meat in quality and the potential for rabbit production is high since other meat sources are expensive and out of reach by most families. They exhibits unique feeding habits and have a

feeding habit known as caecothrophy i.e. an excretion and immediate consumption of its soft feaces. They are also coprophagic i.e. eat their hard feaces or “caecotrophes”. Consequently daily feed intake of rabbits is constituted of two meals i.e. the rabbit feed and the caecotrophes, and conventional feeds. Gidenne. et; al. (2006).

The benefits of *cunniculture* include manure (feaces), rabbit urine as bio-fertilizer, meat, skin and fur.

RABBITS BREED: The breed which was used in this research was New Zealand white-

Characteristics.

(i) Predominantly white body.

(ii) It has characteristic pink eyes

(iii) It can weigh 2-3 kg LWT.

(iv) It can give 50 kitten per doe per year

(v) It can produce a litter size of 5-7 kits per kindling.

Rabbit feeding

Growing rabbit requires a daily ration of 200-250gms of concentrate which have CP of 17% , fats 2%, CF 14-17% , lysine 0.5%, Vitamins; A, D, E, K & B complex vitamin and minerals.

Other feeding regimes include:-

Roughage hay/weeds, Succulent food stuff of green quality, Concentrate feeds, and Compounded feeds e.g. rabbit pellets- intake is 120 gm-150 gm a day. Lactating does = 350-380 gm a day

Other feeds are chopped Napier, sweet potatoes vines, French grass (wilt for 4 days).

Feeding of concentrates:-

I. 0-16 Weeks after weaning requires 65-100g a day,

II. Pregnancy diet requires-225 gms per doe per day

III. Active bucks requires 90-100g per day.

3.2 Materials

- A rabbit hutch was constructed to house 30 growing rabbits (6 m x 2m x 2.5m) and plots of 20 x 10 m seedbed was prepared for the legumes, which were planted using DAP fertilizer. A weighing scale (digital type) with 0.1 grams minimum and 5000 gram maximum readings was used for taking the weights of the rabbits and the feeds

Plate 8: A rabbit hutch with rabbits in their cages

(Source :Author 2016)

3.3 Methodology

(a) Land preparation for each legume

Field establishment was done to achieve a clean, fine and firm seedbed for planting the small seeds for good germination percentage. Vetch was sourced weekly from the naturally occurring pastures. Rhodes grass was also established and cut into hay..

Land preparation and establishment was done in December 2015 and by March/April 2016, the crops were mature for feeding rabbits.

Establishment was by hand drilling in rows and by direct sowing at recommended rates and Diamonium Phosphate (D.A.P) fertilizer was applied for proper rooting. The agronomical practices of weed control, top dressing, pests and disease control and harvesting and utilization were undertaken routinely. Five does were bred to two New Zealand and kindling occurred in January – February 2015 and were weaned in April when the experiment started after suckling their does for three and half months.

3.4 Experiment 1: Nutrient composition for the legumes

Table 3.1 Experimental layout; the experimental design was a CRD of 5 treatments x 2 replicate samples.

	T1 Desmodium	T2 Lucerne	T3 Vetch	T4 Beans	T5(Control) Rhodes grass
R1 (Samples)	Sa_1	Sa_1	Sa_1	Sa_1	Sa_1
R2 (Samples)	Sa_2	Sa_2	Sa_2	Sa_2	Sa_2
Sample Means					

Data set for % DM, % NDF % CP % CF, % ASH, % ME % EE.

The 4 legumes and the Rhodes grass constituted the 5 treatments and were replicated twice, 500 gms sample from each of the four legumes and from the Rhodes grass control sample were collected after drying at 105C^{o} to remove excess moisture and the samples were taken to KALRO Animal feds laboratory Naivasha for proximate

analysis to evaluate their nutrient composition in terms of DM, CP, CF, Mineral, NDF, and ME (Kcal). All the crops were harvested at flowering stage.

3.5 Experiment 2: Effects of the legumes on feed intake, F.C.E and growth rate of growing rabbits fed adlib

Table 3.2 Experimental Layout:- The experimental design was a CRD of 5 Treatments by three replicates with 2 rabbits per replicate.

	T1 Desmodium	T2 Lucerne	T3 Vetch	T4 Beans	T5 (Control) Rhodes grass
Replicate1	2 Rabbits	2 Rabbits	2 Rabbits	2 Rabbits	2 Rabbits
Replicate2	2 Rabbits	2 Rabbits	2 Rabbits	2 Rabbits	2 Rabbits
Replicate3	2 Rabbits	2 Rabbits	2 Rabbits	2 Rabbits	2 Rabbits
Treatment Means					

Data set for weight gain, feed intake & FCE

Plates 1, 2, 3, 4, 5 represents, *Desmodium*, *Lucerne*, *Vetch*, beans and *rhodes* grass being weighed before feeding them to rabbits.

Plate 9: Desmodium being weighed before being fed to rabbits **(Source: Author, 2016)**

Plate10: Lucerne being weighed before being fed to rabbits. **(Source: Author**

Plate 11: Vetch being weighed before being fed to Rabbits

(Source: Author, 2016)

Plate 12: Phaseolus vulgaris (beans) stems and leaves being weighed before being fed to rabbits.

(Source: Author, 2016)

Plate 13: *Rhodes* grass hay being weighed before being fed to rabbits.

(Source: Author, 2016)

Plate 14: Rabbit being weighed to monitor weight gain

(Source: Author, 2016)

Plate 15: Rectal temperature being taken on a calm rabbit

(Source: Author 2016)

Table 3.3: Organ/ Systems weights (gm)

	T1 Desmodium	T2 Lucerne	T3 Vetch	T4 Beans	T5(Control) Rhodes grass
R1	2 Rabbits	2 Rabbits	2 Rabbits	2 Rabbits	2 Rabbits
R2	2 Rabbits	2 Rabbits	2 Rabbits	2 Rabbits	2 Rabbits
Treatment Mean					

Data set:- weights of stomach, liver and kidneys.

At the end of the experiment (1 month) two rabbits from each treatment were sacrificed and their gastro-intestinal organs, liver, Lungs and kidneys examined for

any patho-physiological abnormalities and the organs were weighed and the data set was used to compare with those of the controls.

Table 3.4: Experiment 3 Toxicity investigation

Crops	**Desmodium**	**Lucerne**	**Vetch**	**Beans**	**Rhodes grass**
Score					

Where: 1 = Toxicity signs on live rabbit e.g. alopecia, fur licking, e.t.c and post-mortem signs

were observed in all the three organs i.e. liver, lungs, kidney.

2 = Toxicity signs on live rabbits observed ante-mortem and at post-mortem only on

any two of the three organs e.g. liver and lungs only.

3.= Toxicity signs on live rabbits observed ante-mortem and at post-mortem only

on only one of the three organs e.g. kidney only.

4.= Toxicity signs only observed at post-mortem on only one of the organs e.g.

lungs only.

5. = No toxicity sign observed ante-mortem and post-mortem.

Toxicity Score scale of 1- 5 i.e. from highest toxicity to lowest toxicity score respectively. This scale was developed by the author (2016) based on a formatted scale used by the British society for science and education, united kingdom - SSE-UK (2016).

3.6 Experimental design - CRD

3.7 Model equation

The model equation is a linear model i.e.

$Yij = \mu + ai + eij$

Where

Yij = the total observation on the j^{th} sampling unit of the i^{th} treatment.

U = overall population mean

ai = effects due to i^{th} treatment

eij = random error associated with yij

3.8 Data Analysis

The data was subjected to ANOVA and tested at 5% level of significance ($p<0.05$).

CHAPTER FOUR

RESULTS

At the end of the experiment, the results of nutritional value, growth performance, feed conversion efficiency and toxicological investigation were recorded and tabulated as shown below.

4.1. Experiment 1- Analyzed Nutritional composition of forages/legumes

The results of proximate analysis for nutritional composition of the field forages fed to grower rabbits (% DM Basis) are as shown in Table 4.1

Table 4.1: Nutritional Composition of the forage legumes

Nutrient	DESMODIUM (T1)	LUCERNE (T2)	VETCH (T3)	BEAN (T4)	RHODES (T5)	MEAN ± Std
% CP	21.05	20.66	25.9	28.9	6.7	20.642 ± 8.52
% DM	88.08	87.62	86.9	86.69	87.53	87.364 ± 0.57
% ASH	7.36	10.13	10.8	10.99	8.68	9.592 ± 1.54
% EE	1.33	1.51	0.4	2.16	0.84	1.248 ± 0.67
% NDF	53.38	38.36	36.85	54.86	80.39	52.768 ± 17.53
% MCAL	1.1	1.2	1.16	1.11	0.87	1.088 ± 0.13

The crude protein (%) was as follows; 28.98, 25.90, 21.05, 20.66 and 6.70 i.e. for beans, vetch, green leaf desmodium, Lucerne and Rhodes grass, respectively. This

shows that there was significant difference in crude protein levels amongst the legumes. The dry matter content (DM) in all the forages was about 88% and ME (MCAL); was almost same for all the treatments. Also Ash (mineral content); had almost same values. However E.E & NDF had significantly different values.

4.2 Experiment 2: Effects of legumes on Weight Gain

Table 4.2 (a) Weight gain of rabbits in (gm/day) over a period of 4 weeks.

	DESMODIUM (T 1)	LUCERNE (T2)	VETCH (T 3)	BEAN (T 4)	RHODES (T 5)	SEM
WEEK 1	10.81	8	7.7	6.41	4.43	
WEEK 2	11.25	8.5	8.46	7.65	5.65	
WEEK 3	13.13	7.38	7.58	6.68	6.95	
WEEK 4	15.67	5.96	7.56	6.5	8.18	
MEAN	12.72a	7.5b	7.83b	6.81b	6.3b	+4.305

Figures with same superscripts indicates no significant difference

As indicated in table 4.2(a) desmodium produced significantly better weight gains than the other three legumes.

There was no significant ($p>0.05$) difference in feed intake among the forages as indicated Table 4.2(b) It indicates an average daily feed intake of 130.81 (gm); 106.56 (gm). 117.89 (gm), 119.68 (gm) and 115.23 (gm) for green leaf *desmodium intortum*, lucerne, common vetch, beans and Rhodes grass, respectively during the experiment. The results shows generally a steady increase in feed intake in all the diet from one

week (1`) to the end of the experiment at week 4, except during week 3 where there were reduction in fed intake since the weather had changed to a cold rainy season and the rabbits were stressed.

There was insignificant ($p>0.05$) difference in total feed intake among the five different diets although rabbits on desmodium consumed more than the rest (average of 130.81 gm) while those on Rhodes grass hay (Control) consumed the least (average of 115.23 gm) as shown in Table 4.2. indicating the other legumes i.e. Lucerne, vetch and beans had almost same feed intake of mean of 114.71 gm.

Table 4.2 (b) : Results of feed intake of rabbits in (gms/day) over a period of 4 weeks

	Desmodium	Lucerne	Vetch	Bean	Rhodes grass	SEM
Week 1	112.47	95.23	92.46	118.16	106.19	
Week 2	139.34	113.91	111.49	83.39	123.66	
Week 3	125.60	106.13	100.14	105.27	104.91	
Week 4	144.81	110.95	169.46	171.91	126.13	
MEAN	130.56a	106.56b	118.39a	119.68a	115.22a	+11.032

4.3 Feed Conversion Efficiency

Table 4.3 Showing the feed conversion efficiency (FCE)

The formula used was:

$$\text{FCE} = \frac{\text{WEIGHT GAIN (gm)}}{\text{FEED INTAKE (gm)}}$$

Table 4.3 : Feed conversion efficiency of the rabbits fed on the legumes over the 4 week period.

	DESMODIUM	LUCERNE	VETCH	BEAN	RHODES	SEM
Week 1	0.096	0.084	0.083	0.054	0.042	
Week 2	0.08	0.074	0.075	0.091	0.045	
Week 3	0.104	0.069	0.075	0.063	0.066	
Week 4	0.108	0.053	0.045	0.037	0.648	
MEAN	0.097a	0.070a	0.070a	0.061a	0.200b	+0.060

The diets showed no significant difference ($p>0.05$) in feed conversion efficiency for the legumes although the green leaf desmodium and Rhodes grass indicated the highest feed conversion efficiency of 0.097 and 0.200 while Lucerne, Vetch, and Beans had FCE of 0.070, 0.0.070, 0.061 respectively.

4.4 Experiment 3: Toxicity of legumes to rabbits

Table 4.4 (a): Average daily rectal temperatures taken on 4th day for 12days

	Treatments				
Day	DESMODIUM **T 1**	LUCERNE **T 2**	VETCH **T 3**	BEAN **T 4**	RHODES **T 5**
0	**37.2**	**36.2**	**36.4**	**36.7**	**36.6**
4	**36.2**	**36.3**	**35.1**	**35.2**	**36.8**
8	**36.5**	**35.8**	**34.7**	**34.7**	**36.8**
12	**37.1**	**36.2**	**36.4**	**35.8**	**37.0**
Temperature (Cº)					

The normal body temperature of rabbits ranges from 38.3-39.4

The above table indicates that rabbits fed on beans and vetch had the lowest temperature (hypothermia of 35.8 (Cº) indicative of the toxicity of the legumes which agrees with their toxicity score of 1 and 2, respectively (Table 4.3 (c). However, the rabbits fed on desmodium and Rhodes grass had temperatures of 38.7(Cº) and 36.8

(C^{o}) respectively which are still lower than the normal temperature of 38.3 (C^{o}). Cheeke et; al. (1998).

Table 4.4 (b): Summary of Toxicity scores observed on live rabbits, and postmortem organ systems.

Organs	DESMODIUM **T 1**	LUCERNE **T 2**	VETCH **T 3**	BEAN **T 4**	RHODES **T 5**
Score	**4**	**3**	**2**	**1**	**5**

Toxicity Score scale of 1- 5 i.e. from highest toxicity to lowest toxicity score, respectively. This scale was developed by author (2016) based on a formatted scale used by the British society for science and education, United Kingdom - SSE-UK (2016).

Where: 1 = Toxicity signs on live rabbit e.g. alopecia, fur licking, etc and post-mortem signs

were observed in all the three organs i.e. liver, lungs and kidney.

2 = Toxicity signs on live rabbits observed ante-mortem and at post-mortem only on

any two of the three organs e.g. liver and lungs only.

3.= Toxicity signs on live rabbits observed ante-mortem and at post-mortem only on

only one of the three organs e.g. kidney only.

4.= Toxicity signs only observed at post-mortem on only one of the organs e.g. lungs only.

5. = No toxicity sign observed ante-mortem and post-mortem.

4.4. Organ/system weights.

Table 4.4 (c) Organ systems weights: means of three samples.

	T1	T2	T3	T4	T5	MEAN SEM
GIT	250b	191.4c	198.4c	162.75b	268b	214.11 ±19.48
Liver	94.03b	75.03a	74.17a	59.05c	101.03b	80.662 ±7.53
Kidney	25.05**a**	27.05a	17.75b	11.1c	27.05c	21.6 ±3.13

Means not sharing the same letter are statistically significant P<0.05.

Table 4.4 (d) Observed toxicity symptoms & behaviors

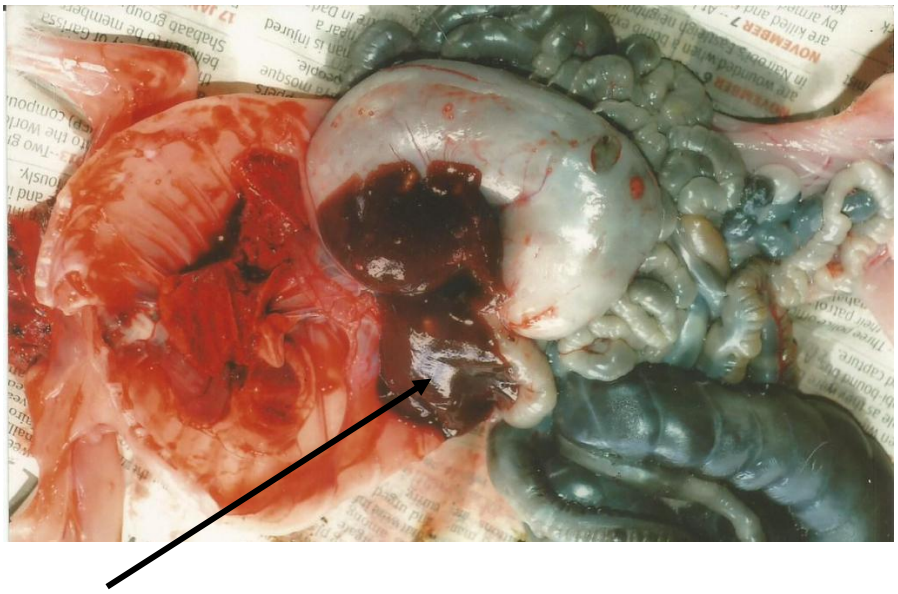
Live rabbit	Item	Desmodium	Lucerne	Vetch	Bean	Rhodes
	(i) Body condition	Fair	Fair/ cachexia	Fair	Poor/ cachexia	Good
Other observations	(i) Fur coat Condition	Good	Good	Good	Poor	Fair
	(ii) Fur licking	Not observed	Lightly observed	Observed	Observed	Not Observed
	(iii) Pica	Not observed	Not observed	Observed	Observed	Not observed
	(iv) Alo pecia	Not observed	Not observed	Observed	Observed	Not observed
	(v) Ear drooping	Not observed	Slightly observed	Observed	Observed	Not observed
	(vi) Limbs Dermatitis	Not observed	Not observed	Not observe d	Observed	Not observed

Table 4.4 (e) Summary of post mortem findings.

Rabbits under desmodium

Body part	Observations	
	Replicate 1	Replicate 2
Live rabbit:		
Body condition score (life rabbit)	Fair	Fair
Fur coat	Good	Good
Post mortem observations:		
Lungs	Ecchymotic hemorrhages	Ecchymotic hemorrhages
Abdomen	Good	Good
Liver	Good (Bright red)	Good (Bright red)
Gastro-intestinal tract	Good, pellet stool	Good, pellet stool
Kidneys	Good	Good

Desmodium was nutritionally adequate as a sole feed. However it could also be associated with a systemic toxic principle that affected lungs, leading to Ecchymotic haemorrhages.



No Lesions on Liver

Plate 16: No Lesions on liver of rabbits fed on desmodium (Source: Author 2016)

Table 4.5 Summary of Postmortem findings for Rabbits given Lucerne feed.

	Observations	
	Replicate 1	**Replicate 2**
Live rabbit		
Body condition score	Fair, cachexia	Fair, cachexia
Fur coat	Good	Good
Post mortem observations		
Lungs	Ecchymotic hemorrhages	Ecchymotic hemorrhages
Abdomen	Dark coloration (deep)	Dark coloration (slight)
Liver	Dark coloration	Dark coloration
Gastro-intestinal tract	Dark and full of contents	Dark and full of contents
Kidneys	Good, reddish urine	Good, reddish urine

Lucerne as a sole feed was nutritionally inadequate. It was also associated with systemic toxic principle(s) that affected lungs and kidneys, leading to haemorrhages.

Plate 17: Dark liver from rabbits fed on Lucerne

(Source: Author 2016)

Table 4.6: Postmortem findings for Rabbits given Vetch feed

	Observations	
	Replicate 1	**Replicate 2**
Live rabbit		
Body condition score	Fair	Fair
Fur coat	Good	Good
Post mortem observations		
Lungs	Diffuse hemorrhages	Diffuse hemorrhages
Abdomen	Dark coloration (slight)	Dark coloration (slight)
Liver	Dark coloration, with pussy spots	Dark coloration, no spots
Gastro-intestinal tract	Good, pellet stool	Good, pellet stool
Kidneys	Good, reddish urine	Good, reddish urine

Vetch as a sole feed was nutritionally inadequate. It was also associated with systemic toxic principle(s) that affected lungs and kidneys, leading to haemorrhages

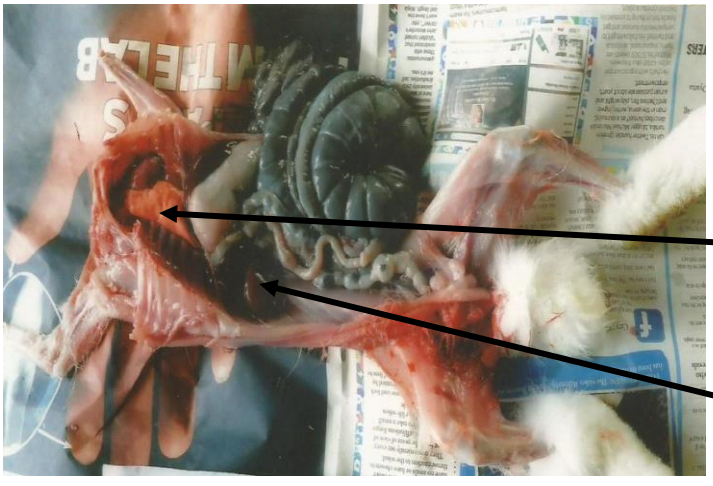


Plate 18: showing lungs with diffused hemorrhages and dark liver with pussy sports. (Source: Author 2016).

Table 4.7: Postmortem findings for Rabbits given bean plant feed

	Observations	
	Replicate 1	**Replicate 2**
Live rabbit		
Body condition score	Poor, cachexia	Poor, cachexia
Fur coat	Poor	Poor
Post mortem observations		
Lungs	Numerous ecchymotic hemorrhages; cachectic carcass	Diffuse hemorrhages
Abdomen	Dark coloration	Dark coloration (slight)
Liver	Dark coloration with pussy spots	Dark coloration with pussy spots
Gastro-intestinal tract	Stomach good, intestines dark with fluid contents	Stomach good, intestines good
Kidneys	Enlarged, urine reddish	Good, reddish urine

Beans as a sole feed was nutritionally poor. It was also associated with a systemic toxic principle (s) that affected lungs and kidneys, leading to haemorrhages. Presence of hepatitis may be attributed to the same principle.

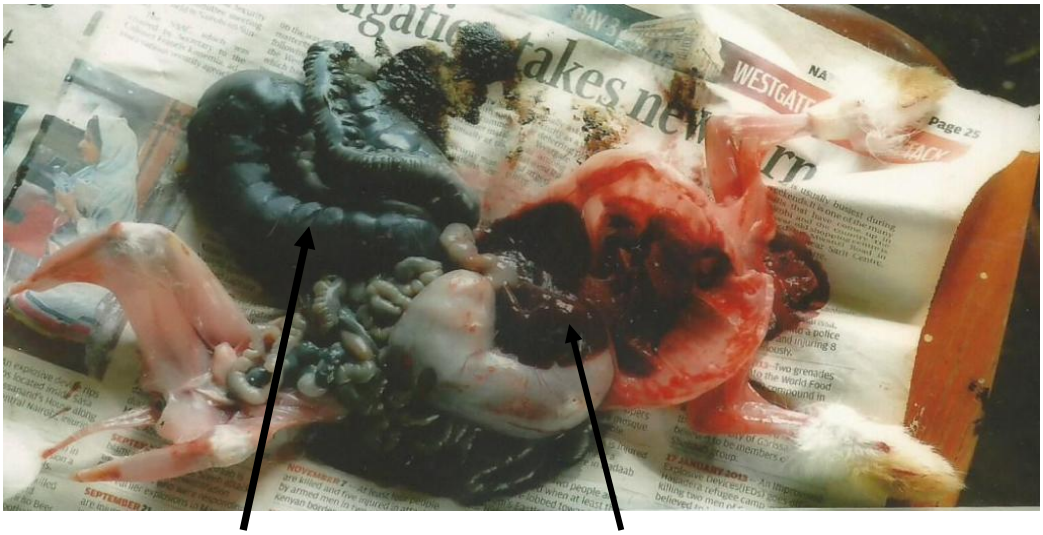


Plate 19: Showing Dark coloured caecum and dark liver or rabbits fed on beans. (Source: Author 2016)

Table 4.8: Postmortem findings Rabbits given Rhodes grass hay.

	Observations	
	Replicate 1	**Replicate 2**
Live rabbit:		
Body condition score	Good	Good
Fur coat	Fair	Fair
Post mortem observations		
Chest	Good	Good
Abdomen	Good	Good
Liver	Good	Good
Gastro-intestinal tract	Good	Good
Kidneys	Good, straw-colored urine	Good, straw-colored urine

Rhodes grass as a sole feed was nutritionally adequate. It showed no toxicity findings and all organ system were normal.

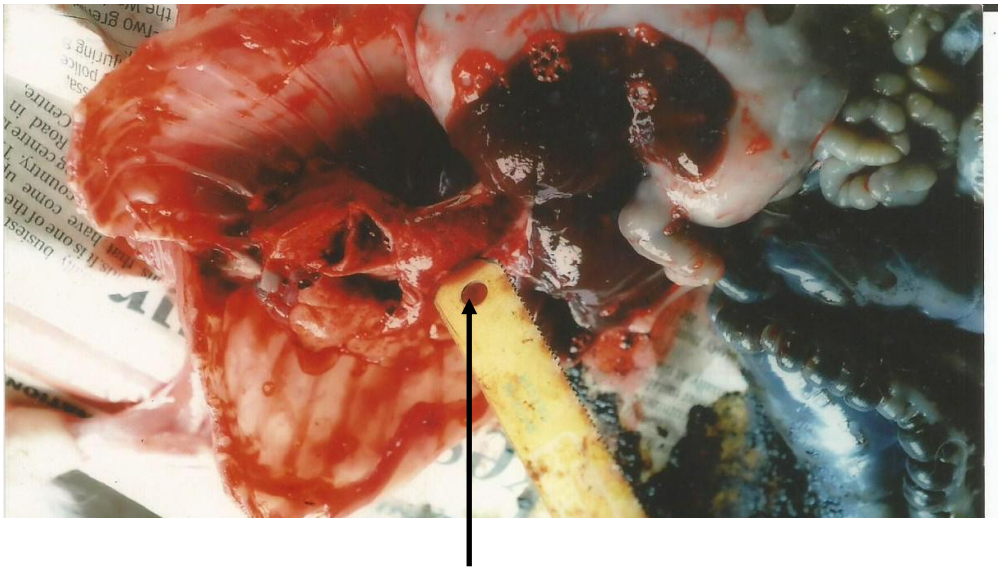


Plate 20: Showing normal organs on rabbits fed on Rhodes grass.

(Source: Author 2016)

The hay, as a sole feed, was good for the rabbits.

Dr. Yegon Moses K. A.
Veterinary Surgeon
KVB-REG NO. 564

Plate 21: Showing normal urine from rabbits fed on Rhodes grass hay and desmodium Legume.

(Source: Author 2016)

Plate 22: Showing haematuria (red urine) from rabbits fed on lucerne, vetch and Beans. (Source: Author 2016)

4.5 Discussion

The results in Table 4.1 show that bean plant had the highest crude protein (CP%) of 28.98 among the legumes while Rhodes grass (control diet) had the least (CP%) of 6.70. Green leaf desmodium had CP% of 21.05 and this compares with another finding which reported a CP% of *desmodium intortum* at 22.2, Katunga et; al (2015). This findings however are higher than in another study which reported a (CP%) of 18.82 in desmodium, Baragahorongye et; al. (2012). Lucerne had a lesser % CP of 20.66 compared to *desmodium intortum* in contrast to the findings of another study which reported a % CP of 23.79, ILRI (2008-2009).

In another experiment the % CP In Lucerne was 13-19 % which suggest that such variation could be due to factors such as soil type where Lucerne is known to be sensitive to low soil pH and also to weather conditions and time of cutting, Martens et; al, (2012). It has also been noted that % CP for dry forages and protein concentrates is a good predictor of crude protein digestibility in rabbits Cheeke et; al, (1998).

Generally all the four tested legumes i.e. desmodium, Lucerne, vetch and beans had a % CP level in the range of 20.66 - 28.98 which is over and above the recommended CP minimum level of 13-17 % needed for maintenance and production requirement, respectively by rabbits. All the diets except Rhodes grass hay had a CP of over 21 suggesting that they can replace the supply of CP for commercial rabbits, feeds, this is according to Proximate analysis findings by Lyeghe et; al, (2006).

The (CP%) in Rhodes grass was lowest at 6.70 but is in agreement with Lyeghe et; al, (2006). The Report stated that the concentration of crude protein in tropical grasses grown and determined in different parts of the world ranged from 2 - 27 % of the dry matter, depending on the stage of growth and level of soil fertility with a mean of 10.6 (CP%). As grasses mature, there is usually a decrease in the % CP due to an increase in the proportion of stem which has lower protein content than the leaf fraction. The crude protein content in both leaf and stem fractions decreases with the age of the plant. The Rhodes grass hay used in this experiment as a control falls within this description.

The % dry matter was generally the same for all the 5 diets with an average of 87% DM which is close to another finding which recorded a % DM of 97.86, 91.86, and 90.58 for beans, Rhodes grass hay and Lucerne respectively, ILRI (2008-2009). The almost similar % DM of average 87 % in all the forages can be attributed to the fact that as the forages matures, the DM Content increases, while the % CP and Ash decreases). All the forages used to feed the experimental rabbits in this experiment were in their flowering (Maturity stage) hence the high percentage DM.

The mineral content (% Ash) in the forages depicted a similar trend ranging from 7.63, 8.68, 10.8, 10.99 and 10.13 (% Ash) for desmodium, Rhodes grass hay, Vetch, bean, and Lucerne respectively. Table 4.1 Indicates that the forages had different levels of minerals with bean having the highest. This results are not in agreement with

the findings on ILRI (2008-2009) which recorded the mineral levels for Rhodes grass hay, desmodium and Lucerne at 9%, 9%, and 13% respectively. Other research findings have shown that there is insignificant difference ($p>0.05$) in mineral levels in *desmodium intortum* with respect to stage of maturity. However, the same can not be probably said on the other forages and is subject to further research. Desmodium and Rhodes grass hay had % Ash of 7.63 and 8.68, respectively which is indicated for rabbits as per proximate analysis results done by Lyeghe et; al, (2006). It also shows that Lucerne, Vetch and Bean had high percentage Ash levels of 10.13, 10.8, and 10.99 respectively.

The Ether Extract (EE) in bean was highest at 2.16 (% DM) while Vetch had the lowest EE% of 0.4. Desmodium, Lucerne and Rhodes grass hay had almost same levels of % .E.E. All the legumes and Rhodes grass hay had % E.E. which was far below the recommended levels indicated for commercial rabbit meal of 12.61, Lyeghe et; al, (2006).

The NDF (Neutral Detergent Fibre) was highest in Rhodes grass at mean of 80.39 %, while desmodium, Lucerne, bean and vetch had almost same levels in NDF. This is not in agreement with another study which recorded NDF levels for Rhodes grass hay and Lucerne at 65% and 44% respectively and 54% for bean, ILRI (2008-2009). The Desmodium NDF % of 53.38 in this experiment also do not agree with another finding which reported a value of 64.% NDF, Maas et; al, (2015). It also differs with the findings of another study which reported % NDF of 46.97 for desmodium, Lebas et; al. (1998). The Rhodes grass hay according to Ontiti et; al had the % NDF of 68.34 which is lower than the findings of this experiment of % NDF 80.39. This could be attributed to the different agro-ecological zones where the crops were planted i.e. for this experiment at Kapsabet Nandi County in Agro Eco Zone III and in Lanet Naivasha Agro Eco Zone IV.

The metabolizable energy (MCAL means) was very similar in all the forages ranging from lowest of 0.8654 for Rhodes grass to 1.196 for Lucerne. This is more or less in agreement with the findings of another experiment which recorded MCAL of 1.74 for Lucerne hay and 1.20 ME/CAL for Rhodes grass hay, 1.14 Mcal for bean, ILRI (2008-2009). The rabbits requires a Kcal maintenance of 2.1 to 2.2 Kcal. Per kilo of feed and reproduction and growth needs 0.3 – 0.5 Kcal per kilo above maintenance requirements, Deblass et; al, (2003).

Other researchers have demonstrated through laboratory analysis that the energy (Mcal) value of forages varies depending on the period of maturity e.g. before or after flowering stage, Baragahoranye et; al (2012). In this research all the forages were fed to growing rabbits after the flowering stage and this can explain the more or less similar Mcal.

The average daily intake for rabbits fed on the five diets were 138.81, 106.56, 117.89. 119.68 and 115.23 gm for Desmodium, Lucerne, Vetch, Bean and Rhodes grass hay, respectively.

From Table 4.2(b) of the results, it can be seen that the daily feed intake reduced in the 3rd week of the study and this can be attributed to the onset of long rains in the study area accompanied by cold weather which may have stressed the rabbits. Also the dry matter levels in the feeds had started increasing as the plants continued to grow towards maturity. Generally the feed intake was similar. This similarity in feed intake tends to agree with the findings of Fredrick (2012). Inspite of this, Desmodium group had the highest feed intake while Rhodes grass hay group had the least. The higher intake on desmodium could be due to its good palatability, Katunga et; al, (2014). Such difference in feed intake could be attributed to several factors e.g. age of the animal, energy concentration of the feed, differences in general management practices, and presence of anti-nutritional factors /toxic compounds.

The FCE Table 4.3 ranged from 0.097,0.070,0.070, 0.0061 and 0.200 for Desmodium, Lucerne, Vetch, Bean and Rhodes grass hay respectively. Statistically there was no significant difference ($p>0.05$) in FCE, but desmodium had the highest FCE of 0.097 amongst the legumes and Rhodes grass hay had the highest of 0.200.

The Average Daily Gain (ADG) Table 4.2 (a) recorded in this study were. 12.72, 7.5, 7.83, 6.81 and 6.3 (gm) for Desmodium, Lucerne, Vetch, Beans and Rhodes, respectively. Variations in body weight and rate of gain of rabbits have been attributed to differences in the nutrient composition of the forages served, Asuguo (1997). The ADG also in this study agrees with the growth rate of 5-10 gms per day as reported in another study during the growing phase, Lyeghe et; al, (2006).

There was significant difference ($P<0.05$) in average daily weight gain (ADG) where the Desmodium fed Rabbits had the highest gain of 12.72, while Vetch, Lucerne, Bean and Rhodes grass hay had ADG of 7.83, 7.5, 6.81, and 6.30 respectively. This may be attributed to the fact that Desmodium, had the 3rd highest % CP of 21.0 which is above the recommended level of 13-17 % CP for maintenance. Most legumes posses chemical compounds which causes agglutination of Red blood cells and such compounds may have nutritional significance as indicated by the fact that purified preparations of these plant immoglutinins inhibit growth when incorporated in diets and research of tannins inforage legumes has shown their negative effect on protein digestion and metabolism, Irvine (2015). The average daily gain in this study are lower than the findings of another study which recorded an ADG of between 18.1 – 21.2 gm for rabbits fed on 2 legumes, that is Gliricidia and Leucaena sp, Cheeke et; al, (1987). The rabbits fed on Lucerne, Vetch and Beans did not show a corresponding increase in weight in spite of the high percentage of CP in this legumes. This may be due to the presence of anti-nutritional factors and/or toxic compounds which retards

growth. The ADG for Rhodes grass group can be acceptable due to the low percent CP in Rhodes grass hay.

The high ADG in desmodium may suggest that it could be having Less anti-nutritional factors and /or toxic compounds compared to other legumes. One clear observation in this study with respect to weight gains is that despite adequate protein intake from the different legumes, the high protein intake by grower rabbits may not be effectively converted to high growth rate. It would be anticipated that higher protein intake by rabbits should convert to higher weight gain but it appears not to be the case in this study, especially for Lucerne, Vetch and Bean groups of rabbits. This observation tends to agree with another finding which alluded that low weight gains obtained could probably be due to genetic ceiling placed on growth during the growth phase as the growing rabbits approach puberty, Lyeghe et; al, (2006). The low ADG in the same group (Lucerne, Vetch and Bean) may also be associated with the presence of anti-nutritional and / or toxic factors in the forages as per their toxicity scores.

It is also noted that from the 3rd week of study, the growth rate reduced for the group fed on Lucerne, Vetch and beans. This may be explained by the onset of the long rain and extreme weather conditions or could be due to presence of anti-nutritional factors/toxic compounds which could be in the legumes and have been accumulating in the rabbits body system and starting to exert growth inhibition. This scenario, however, was not observed with the desmodium and Rhodes grass hay group of rabbits. The rabbits were kept in same hutch to take care of environmental effects since good ventilation was provided for to take care of the prevailing ambient temperatures.

The ADG recorded in this study for desmodium fed rabbits concurs with the values of 12.32gms reported by Odoh et; al, (2007). However they are much higher than those

reported of 3.65 - 9.57; and 4.72 – 6.94gm when rabbits where fed diets having protein levels similar to those used in this study, Olabanjo et; al, (2007), Omoren et; al (2007).

Postmortem observations

The post mortem observation indicated that the rabbits on desmodium and lucerne had Ecchymotic haemorrhages in the lung parenchyma (tissue) while the rabbits on Vetch and Beans had diffused haemorrhages' and cachexic carcass was observed in the bean group. The rabbits on the Rhodes grass hay (control group) did not exhibit any patho-physiological signs of disease condition. This is a pointer to suspect the leguminous plants to possess anti-nutritional/toxic compounds which do cause hemorrhages in the thoracic organs and tissues.

The intestinal organs of rabbits fed on Vetch, Desmodium and Rhodes grass hay had good pelleted stool while those on Lucerne had dark stool full of fluidy contents in one rabbit.

Pelleted stool in rabbits is a normal condition but the fluidy content in beans is suggestive of a disease condition or toxicity.

It can also be noted that rabbits under desmodium had minimal toxicity signs unlike those on bean, Vetch and Lucerne, which had severe Ecchymotic and diffused hemorrhages on the lungs and liver. (Refer Plate 17, 18 and 19). The Rhodes grass group did not show any such lesions (Refer to plate 20).

The livers of rabbits fed on Rhodes grass had no lesions and were bright red in colour (normal) while the livers of rabbits fed on lucerne, Vetch and beans had dark coloration with pussy sports (whitish sports with puss).

The rabbits fed on Rhodes grass hay, desmodium, Lucerne, Vetch and beans had good (normal kidneys, but those on Lucerne, Vetch and beans had haematuria (reddish urine)- (refer to plate 22). This is abnormal and indicative of haemolysis of cells in the body. This, however, was not seen in the rabbits fed on Rhodes grass as the control and those on Desmodium legume .This implicates the three legumes i.e. Lucerne, Vetch and Beans as having toxic compounds that causes blood cells destruction. The urine of rabbits fed on Rhodes grass hay (control) and Desmodium legume had straw – coloured urine (normal), (refer to plate 21).

In. table 4.4(c) the study revealed a wide range in organ/system weights where Rhodes grass control group of rabbits had the highest weight of 268gm of the GIT and the bean group had the lowest of 162.75 gm. This is also true for weights of liver and kidneys where Rhodes grass group had the highest weight of 27.05 gm and the bean group had 11.1 gm and also the Rhodes group had the highest kidney weight of 8.05 gm while the bean group had the lowest of 3.3gm. This weight variations in organs is suggestive of patho-physiological effects associated with the legume species which are not seen in the Rhodes grass which was the control group.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

- The four legumes i.e. desmodium, Lucerne, Vetch and Beans had a% CP range of 20.66 – 28.9 which is over and above the required for maintenance and production by growing livestock e.g. ruminants and rabbits.
- The study showed that the legumes can support good growth of 6.81 – 12.72 grams/day rate but low feed conversion efficiency.
- The results of this study showed that of the four legumes the most palatable was desmodium due to highest feed intake of 130.56g/day compared to Rhodes grass at 115.22 g/day.
- The study indicated the possible presence of anti-nutritional factors /deficiencies mainly in Vetch, Lucerne and beans and their absence in Desmodium and Rhodes grass
- Desmodium is the best legume in terms of nutritive value and also has no anti-nutritional factors/deficiencies.

Recommendation

The best legume to recommend to farmers is desmodium.

- All the four legumes can be used as protein supplements in ruminants when other feeds forms the bulk of the ration.

REFERENCES

Africa Animal Agriculture: Macro-trends and future opportunities. *Proceedings of the 6th All African conference on Animal agriculture 27-30 October*, (2014). K.I.C.C. Nairobi, Kenya.

Akinmutimi, A.H.,et, al (2007) *growth performance of weaner rabbits fed on sweet potatoes.*

Amaefule, K.U., et, al(2005) a note on the growth performance and carcass characteristics of rabbits fed graded dietary levels of boiled pigeon pea seed (cajanus cajan). *Livestock Research for rural development 17(5).*

Amy E. Halls, M.Sc. (2010).-: *Nutritional requirements for rabbits.* Monogastric Nutritionist shur-gain, Nutreco Canada inc. Oct. 2010.

Asuguo BO (1997). Nutritional potentials of Ipomea, centrosema, puraria, Emilia and tridax forages in mixed feds for weaner rabbits. *Nigerian Journal of Animal Production*. 24(1):46-50.

B. Puschner, (2008) *Plant poisonings in livestock; in proceedings, Alfalfa & Forage Symposium and western Seed Conference,* 2-4, San Diego, CA, UC, Cooperative Extension, Agronomy Research and Extension centre. Plant science department, university of California.

Baker, D.A. (1986). *Problems of pitfalls in animal experiments designed to establish dietary bananas* http://www.fao.org/DOCEP/003/T0554E/T0554E16.htm.

Baragohoranye Innocent, Mupenzi Jean da la Paix, Habiyaremnye Gabriel (2012): Comparative study of the nutritive value and productivity of Desmodium, Desmodium intortum and Brachairia mutica in two periods of development, case study of RAB-Musanze, *Journal of American Science* 2012, 8(3): 240-245}. ISSN: 1545-1003. http://sss.americanscience. Org. 32.

Bayble, T., S. Melaku and NK. Prasad 2007 *Effect of cutting dates on nutritive value of Napier*(Pennisetum purpureum) grass sole and in association with Desmodium (Desmodium intortum) or Lablab (Lablab purpureus) Livestock Research for Rural Development 19 (1) 200.

Bindelle, J., Ilunga, Y., Delacollette, M., Muland, K. M., Umba, D. M'Balu. J., Kindele, E., & Buldgen, A. (2007). *Voluntary intake, chemical composition and* in vitro *digestibility of fresh forages fed to Calves in periurban rearing systems of Kinshasa* (Democratic Republic of Congo). *Tropical Animal Health and Production, 39(6),* 419-426. http://dx.doi.org/10.1007/sll250-007-9036-y Cader, Bill., Lethbridge, Canada. (2007).

Boisen, S. 1997. *Ideal protein - and its suitability to characterize protein quality in pig feeds*. Caloric restriction.Toxicol. Pathol. 24, 738 –741.

Cheeke PR. 1998, *Natural toxicants in feeds, forages, and poisonous plants.* 2nd d. pp. 338-352. Interstate publishers, inc., Danville, IL.

Cheeke, P. R., Patton, N. M., Lukefahr, S. D., and McNitt, J. I. (Eds.) (1987). *Rabbit Production.* Interstate Printers & Publishers, Inc., Danville, Illinois.

Cheeke, P.R., 2003. *Feeding systems for tropical rabbit production emphasizing root and tubers*.

Cook, B., Pengelly, B., Brown, S., Donnelly, J., Eagles, D., Franco, A.,…. Schultze-Kraft, r. desempenho. *Acta Scientiarum,* 22(3), 829-833.

Eastern and Southern Africa. International Institute for Rural Reconstruction (IIRR). ISBN 9966-9705-2-5.

FAO (2010) *The State of Food Insecurity in the World 2010*. PG 26.

FAO. 2014. *The State of Food and Agriculture* 2014. Innovation in family farming. Rome.

Finch, C.E. (1990). Longevity, Senescence and the Genome. The University of Chicago Press, Chicago, II. Forage Legumes in South-Kivu, D.R. Congo. *American Journal of Plant Sciences,* 5, 1384- 1393.

Forage Legumes in South-Kivu, D.R. Congo. *American Journal of Plant Sciences*, 5, 1384-1393. from: http://rabbitresource.org/body-temp/.

Gidenne, T. (2006). *Evaluation of concentrates, grass and legume combination on performance and nutrient digestibility of grower rabbits under tropical condition*.

Heinritz, S. N., Hoedtke, S., Martens, S. D., Peters, M, & Zeyner, A. (2012). *Evaluation of ten tropical legume fodders for their potential as pig feed supplement. Livestock Research for Rural Development, 24* (1*).* holder farmers in the tropics. Hoolehua Plant Materials Center, Hoolehua, Hawaii.

Houndonougbo F. M., A. Chwalibog, and C. A. A. M. Chrysostome, (2008) *"Nutritional and economic values of by-product used in poultry diets in Benin:* The case of soybean, cotton and palm kernel meals," *livestock research for Rural Development*, Vol.10 no. 11, 2008. View of scopus.

ILRI (2008 – 2009) *Feed composition* (AST Africa).

ILRI, (2013) *Lablab (*Lablab purpureus *cultivar Rongai) for livestock feed on small–scale farms*. ILRI Forage Factsheet, Nairobi, Kenya

Irvinee. L. (2015) Department of Agricultural , Biochemistry University of Minesota St.Paul Minesota. *Journal of Animal Science, 8 (2), 625-627*. Kluwer academic publishers, Jan langer, (2001).House rabbit resource network.

Jones ND (1990). *The developing market for farm bred meat rabbit in Britain*.

Kari (2010) *Promotion of range pasture and fodder production among the pastoral and agro-pastoral communities in Kenyan rangelands: Experiences and lessons learnt*

Katunga D.M.M (2015*)* feeding rabbits in traditional system with improved forage legume in south-Kivu DR. Congo. *Journal of applied Biotechnology*. ISSN2327-0640 2015, Vol. 3, NO. 1.

Katunga, M.M.D., et al. (2014) *Testing Agro -Ecological Adaptation of Improved Herbaceous.*

Kebede, T.; T. Lemma; E. Tadesse and M. Guru (2008). Effect of level of substitution of sweet potato (Ipomoea Batatas. L) vines for concentrate on body weight gain and carcass characteristics of browsing Arsi -Bale goats. *Journal of Cell and Animal Biology*, 2: 036–042.

Kevin P. Keenan (1999). Diet caloric restriction and the rodent Bioassay. *Toxicological science* 52(Supplement), 24-24 (1999).

Kumar, R. and Vaithiyanathan, S. (1990). *Occurrence, nutritional significance and effect on animal productivity of tannins in tree leaves, animal feed science and Technology 30:21-38.*

Langer, Jan . (2001). *Body temperature. Hourse Rabbit Resource Network (HRRN*). Available from: http://rabbitresource.org/body-temp/.

Lebas F., T Hébault R.G., A llain D., (1998)a: *Nutritional recommendations and feeding ligneux sur l'evolution ponderale des ovins de la race naine de l'Afrique de l'Ouest* .

Lyeghe – Erakpotobor (2006).*Evaluation of concentrate, grass and legume combinations on performance and nutrient digestibility of grower rabbits under tropical conditions*.

M. Fredrick Houndonougbo, 1C. A.A.M chrysostome, 1 S.E. Attakpa, 2. A. Sezan, 2 and H.B. Dehou1(2012) . *Faculty of agronokic science, university of Abomey Calavi, 01BP 526 Cotonou, Benin.*

Maass N. Buer, 2015, Application of herbs and propolis in rabbits chronic diarrhea. *Turkish Journal of Veterinary and Animal Sciences.*

Maina, J. M. ; Mburu, M. W. K. ; Mureithi, J. G. ; Gachene, C. K. K. ; Mburu, J. N. ; Ngugi, J. N. ; Kimemia, J. K., 2006. *Evaluation of legumes as cover crops for soil and weed management in smallholder coffee cropping systems in Central Kenya*. In: Proc. 10th KARI Bien. Sci. Conf., "Responding to demands and opportunities through innovative agricultural technologies, knowledge and approaches", 2 - 17 November 2006, Nairobi, Kenya.

Martens et; al, (2012) *Feeding forages to monogastric livestock &limitation for small holder farmers in the tropics.*

Masoro, E. J. (1996). *Possible mechanisms underlying the anti-aging actions of caloric restriction.Toxicol*. Pathol. 24, 738 –741.

Odoh, O.E., Onuh, S.O. and Lorgyer, M.L. (2007). *Effect of flushing on the reproductive Performance of rabbits*. Proceedings f the 32nd annual conference of then IGERIAN Society for Animal Production, 18-21 MARCH, 2007, Calabar. Nigeria.

Olabanjo, et, al (2007) *Growth performance and haematological characteristics of weaner rabbits fed different levels of wild flower (Tithonia Diversifolia Heml A Gray) leaf-blood meal mixture*. Proceedings of 32nd annual conference of the Nigeria society for animal production, 18-21 march , 2007 calabar, Nigeria.

Omoren. U.E. and Ojo, (2007). *Comparative evaluation of Maize, cassava, cocoyam and Icadinia manni as energy source of growing rabbits*. Proceedings of the 32nd Annual conference of the Nigeria for Animal production 18-21, March, 2007. Calabar, Nigeria.

Orengo, .1. & Gidenne, T. (2007). *Feeding behaviour and caecotrophy in the young rabbit before weaning:* An approach by analyzing the digestive contents. *Applied Animal Behaviour Science* 102. 106-118.

Osunga, I.M., Wambui, C. C., Abdulrazak, S..A. Ichinohe , T., & Fijihara, T. (2008). Evaluation of nutritive value and palatability by goats and sheep of selected browse foliages from semiarid area of Kenya. Animal *Science Journal*, 79, 282-289. http://dx.doi.org/10.1111/j.1740-0929.2008.00567

Ouda JO (2001*). Feeding and care of livestock In: Managing dry land resources. A manual for peels in place of maize base diet*. Proceedings of 32nd Annual production. university of calabar, calabar, march 18th -21st 2007.347-349.

performance of rabbits. Proceedings f the 32nd annual conference of then IGERIAN Society for Animal Production, 18-21 MARCH, 2007, Calabar. Nigeria.

Peter S. Eggli, Ernest B. Hunazinker and Robert K. Schenk,(1988). *Quantitation of Structural Features characterizing weight-and less-weight-bearing character regions analysis of medical femoral Condyles in young adult rabbits*. Vol. 222 Issue 3 pages 217-227.

Sharkey M. J. (1971).*Some aspects of coprophagy in rabbits and guinea pigs fed fresh Lucerne.*

Skerman, P.J Cameroon, D.G. Riverros, F. Tropical Forage Legumes.2nd ed; *Food and Agricultural Organization of the United Nations; Rome, Italy, 1988. Source for growing rabbits*.

Proceedings of the 32nd annual conference of the Nigeria society for Animal Production 18-21, march, 2007 calabar, Nigeria.

Society for Science and Education-United Kingdom, (2016) *(Formatted toxicity Score Scale).* south-Kivu DR. Congo. *Journal of applied Biotechnology*. ISSN2327-0640 2015,

Vol. 3, NO. 1 U.S.D.A (2012): *Natural resources conservation service plant material program*. 'Kuiaha Desmodium. Desmodium intortum (Mil.) Urb. Conservation Plant Release by USDA NRCS value and palatability by goats and sheep of selected browse foliages from semi-arid area of Kenya. www.tropicalfodders.info.

APPENDICES

APPENDIX 1

Kenya Agricultural and Livestock Research Organisation
KENYA DAIRY RESEARCH INSTITUTE
P.O. Box 25 - 20117, Tel: + 020 2390930, NAIVASHA
E-mail: karinaivasha@gmail.com or karinaivasha@yahoo.com

REF: NIRS ANALYSIS RESULTS FOR YOUR FEED SAMPLES

PAUL MUTAI - University of Eldoret

We are pleased to let you know that the feed samples you posted to our NIRS Laboratory have been successfully analyzed and the results are detailed in the table below:-

Date Samples Delivered .....20th JUNE 2016 Date Samples Results Collected...23rd JUNE 2016

1	CHEMICAL COMPONENT ⇨	Ash (%)	Dry matter (%)	Crude Protein (%)	Crude Fat (%)	Neutral Detergent Fibre (%)	Acid Detergent Fibre (%)
1	T3 V1	10.29	86.99	25.40	0.58	37.00	27.95
2	T3 V2	11.31	86.81	26.41	0.22	36.69	28.62
3	T2 L1	8.99	87.67	20.88	1.84	39.69	27.06
4	T2 L2	11.26	87.56	20.44	1.17	37.03	25.90
5	T1 B1	8.34	88.42	21.34	1.06	55.81	34.60
6	T1 B2	6.91	87.69	20.75	1.59	50.94	29.12
7	T4 B2	11.65	86.73	29.06	1.33	54.87	32.59
8	T4 B1	10.32	86.64	28.91	2.99	54.84	29.27
9	T5 R1	9.07	87.31	6.85	1.37	79.11	44.39
10	T5 R2	8.29	87.74	6.55	0.31	81.67	49.99

Dr Evans Ilatsia
Centre Director/KALRO Naivasha

APPENDIX II

Kenya Agricultural and Livestock Research Organisation

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REF: NIRS ANALYSIS RESULTS FOR YOUR FEED SAMPLE

PAUL A. MUTAI

We are pleased to let you know that the feed samples you posted to our NIRS Laboratory have been successfully analyzed and the results are detailed in the table below:-

Date Samples Delivered ….**…4th July 2016** Date Samples Results Collected**…5thJuly 2016**

	CHEMICAL COMPONENT ⇨	Metabolizable Energy MCal
1	T3 V1	1.1691
2	T3 V2	1.1570
3	T2 L1	1.1854
4	T2 L2	1.2066
5	T1 R1	1.0476
6	T1 R2	1.1478
7	T4 B2	1.0844
8	T4 B1	1.1450
9	T5 R1	0.8633
10	T5 R2	0.8674

Dr Evans Ilatsia

Centre Director/KALRO Naivasha

APPENDIX III:

FORAGES - RANKING

Crop	Parameter	Rank (1-5) (lowest to Highest.)
1. Desmodium	(a) Nutritional value-based on analysis	3
	(b) Nutritional value based on growth performance	5
	(c) Palatability – based on feed intake	5
	(d) Toxicity based on organ weights	4
	*(e) Toxicity based on toxicity score scale.	4
2. Lucerne	(a)Nutritional value-based on analysis	2
	(b) Nutritional value based on growth performance	3
	(c) Palatability – based on feed intake	1
	(d) Toxicity based on organ weights	3
	(e) Toxicity based on toxicity score scale.	3
3. Vetch	(a) Nutritional value-based on analysis	4
	(b) Nutritional value based on growth performance	4
	(c) Palatability – based on feed intake	3
	(d) Toxicity based on organ weights.	2
	(e) Toxicity based on toxicity score scale.	2
4. Bean	(a) Nutritional value-based on analysis	5
	(b) Nutritional value based on growth performance	2
	(c) Palatability – based on feed intake	4
	(d) Toxicity based on organ weights	1
	(e) Toxicity based on toxicity score scale.	1
5. Rhodes grass	(a) Nutritional value-based on analysis.	1
	(b) Nutritional value based on growth performance.	1
	(c) Palatability – based on feed intake.	2
	(d) Toxicity based on organ weights.	5
	(e) Toxicity based on toxicity score scale.	5

* The ranking of the scale of 1-5 applies for parameter **a, b, c, d** which represents the lowest to the highest value but parameter **e** represents toxicity of 5 – 1 representing the lowest toxicity to the highest toxicity. (Refer toxicity scale table).

APPENDIX IV

RABBITS EXAMINATION REPORT ON 5th MAY 2016

1. Rabbits under *Desmodium* feed

Body part	Observations	
	Replicate 1	Replicate 2
Life rabbit		
Body condition score (life rabbit)	Fair	Fair
Fur coat	Good	Good
Post mortem observations		
Chest	Ecchymotic hemorrhages	Ecchymotic hemorrhages
Abdomen	Good	Good
Liver	Good (Bright red)	Good (Bright red)
Gastro-intestinal tract	Good, pellet stool	Good, pellet stool
Kidneys	Good	Good

Desmodium was nutritionally inadequate as a sole feed. It could also be associated with a systemic toxic principle(s) that affected lungs , leading to haemorrhages.

2. Rabbits under Lucerne feed

Body part	Observations	
	Replicate 1	Replicate 2
Life rabbit		
Body condition score	Fair, cachexia	Fair, cachexia
Fur coat	Good	Good
Post mortem observations		
Chest	Ecchymotic hemorrhages	Ecchymotic hemorrhages
Abdomen	Dark coloration (deep)	Dark coloration (slight)
Liver	Dark	Dark coloration
Gastro-intestinal tract	Dark and full of contents	Dark and full of contents
Kidneys	Good, reddish urine	Good, reddish urine

Lucerne as a sole feed was nutritionally inadequate. It could also be associated with systemic toxic principle(s) that affected lungs and kidneys, leading to haemorrhages.

3. Rabbits under Vetch feed

Body part	Observations	
	Replicate 1	Replicate 2
Life rabbit		
Body condition score	Fair	Fair
Fur coat	Good	Good
Post mortem observations		
Chest	Diffuse hemorrhages	Diffuse hemorrhages
Abdomen	Dark coloration (slight)	Dark coloration (slight)
Liver	Dark coloration, with pussy spots	Dark coloration, no spots
Gastro-intestinal tract	Good, pellet stool	Good, pellet stool
Kidneys	Good, reddish urine	Good, reddish urine

Vetch as a sole feed was nutritionally inadequate. It could also be associated with systemic toxic principle(s) that affected lungs and kidneys, leading to haemorrhages.

4. Rabbits under bean plant feed

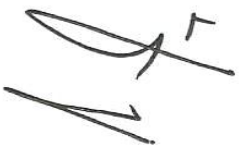
Body part	Observations	
	Replicate 1	Replicate 2
Life rabbit		
Body condition score	Poor, cachexia	Poor, cachexia
Fur coat	Poor	Poor
Post mortem observations		
Chest	Numerous ecchymotic hemorrhages; cachectic carcass	Diffuse hemorrhages
Abdomen	Dark coloration	Dark coloration (slight)
Liver	Dark coloration with pussy spots	Dark coloration with pussy spots
Gastro-intestinal tract	Stomach good, intestines dark with fluid contents	Stomach good, intestines good
Kidneys	Enlarged, urine reddish	Good, reddish urine

Beans as a sole feed was nutritionally poor. It could also be associated with a systemic toxic principle that affected lungs and kidneys, leading to haemorrhages. Presence of hepatitis may be attributed to the same principle, but more tests are required.

5. Rabbits under Rhodes grass hay feed

Body part	Observations	
	Replicate 1	Replicate 2
Life rabbit		
Body condition score	Good	Good
Fur coat	Fair	Fair
Post mortem observations		
Chest	Good	Good
Abdomen	Good	Good
Liver	Good	Good
Gastro-intestinal tract	Good	Good
Kidneys	Good, straw-colored urine	Good, straw-colored urine

The hay, as a sole feed, was good for the rabbits.



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KVB-REG NO. 564