Chapter One
Introduction

Among the constraints facing livestock production in the developing countries, poor animal nutrition and productivity arising from inadequate feed supplies stands as the most important. Growing concerns about this problem have prompted researchers and development planners to search for ways to promote the more efficient utilization of available feed resources. Crop residues—the fibrous by-products which result from the cultivation of cereals, pulses, oil plants, roots and tubers—represent an important feed resource for animal production in developing countries. These residues provide fodder at low cost since they are by-products of existing crop production activities. They are important adjuncts to natural pastures and planted forages and are often used to fill feed gaps during periods of acute shortage of other feed resources. (Timothy *et al,* 1997).

Livestock industry is of great importance to Sudanese economy as it is one of the main sources of food, employment and foreign currency. Sheep population is estimated at 48.136 million heads (Ministry of Animal Resources & Fishery, 2011).

Agricultural by products and agro- industrial byproducts are exclusively used for animal feeding. Cereal grains (mainly sorghum) are also used as other sources of energy in some animal diets for various kinds of livestock production.

According to El Hag, (1985) a survey indicated that over 4.5 million tons of agro - industrials by – products were available in Sudan. It is estimated that the energy present in these by – products could satisfy about 9 % of the maintenance requirements of the animal population in the Sudan The major by – products include cereal straw, ground nut hull and haulms, sugar cane tops, bagasse, molasses, cotton stalks and trash, sesame field residues, wheat bran and cotton seeds cakes and field residues of sorghum and cotton after crop harvest.

Oil seed cakes and milling industry byproducts are additional animal feed ingredients. Animal feed industry or the manufacturing of animal feed started recently and have a considerable share in supplying the livestock production sector with a balanced feed rations especially the dairy and poultry units. Beef cattle and sheep are primarily grazing animals. At certain times they were fed mixed diets at the feedlot of different energy and protein levels (Izeldin, 2008).

The animal owners in Sudan have a limited knowledge of the different nutrients requirement of their animals to allow for fully expressing their genetic production potentials. In addition to that the animal owners spent a lot of time and using a lot of labors to mix the diet ingredients to formulate the animal ration which may render the ingredients to waste. The use of the complete diet system (CDS) or the total mix rations (TMR) is more economic and provides the animal with a uniform mixture of feed ingredients processed in such a way as to avoid differential selection by the animal (Owen, 1979).

Beef cattle as mentioned are grazing animals, but Philip (2001) reported that in parts of Africa, cattle contribute to overgrazing and removal of plant cover in hill regions causing soil erosion. In Sudan the large numbers of cattle impose great pressure on the natural grazing resources and may lead to soil erosion. Around big cities and large towns, feedlots fattening of mainly cattle and sheep is practiced during summer season, where the animals supply is at minimum and animal feeds shows shortage. This fact applies greater importance on finding out some alternative feed sources during period of the shortage and scarcity of animal feeds during this period in Sudan.

The main crop residues under this study (Sorghum straw, Groundnut straw and Sesame straw) were available in a great amount after harvesting season in traditional or mechanized rain fed schemes in Gadarif state without utilization as animal feed resources, and were burned.

Thus, this study is to evaluate the nutritive value of the different crop residues, and the effect of the different crop residues in the sheep lambs fattening process.

CHAPTER TWO
LITERATURE REVIEW

2.1. Sudan desert sheep

According to Mason and Maule (1960) the desert sheep is large, long legged and has a hairy coat which is of different colour according to the ecotype concerned. Desert sheep meat has a high demand locally and for export because of its large carcass that yields good quantity and quality meat. McLeroy (1961_a) indicated that Sudan desert sheep includes seven tribal breeds, namely *Watish*, *Meidob,* Northern reverine wooled Beja, Butana, Gezira and Kababish. (McLeroy, 1961_b). *Watish* are hardy sheep living under relatively high rainfall conditions between latitude 10º and 11ºN and mainly along the Blue Nile, south of Wad Medani into the Fung area. They are mainly owned by nomadic and semi-nomadic tribes including the Kenana, the Rufaa ElHoy and the Beni Meharib.

2.1.1. Livestock Production in Gadarief state

According to the Ministry of Animal Resources and Fishery of Gadarif state (2011), the total number of animals is estimated to be 3.896.134 head. Sheep herds comprise about 48 %of the total animal number followed by goats 24 ،%cattle 24 %and camels are about 4 %Livestock production is the second major economic activity in the state. The animals depend on natural pasture land throughout the year with the exception of the period April-June during which the state experiences deficits in animal feed. Pastoralism is subdivided into nomadic and settled or semi-settled traditional pastoralism. The first category specializing in camel, cattle, sheep and goats are nomadic throughout the year while in the second category, the young people look after the herds and their families remain behind, practicing rain-fed farming. However, the semi or settled pastoralists constitute the prime source of milk to the neighboring cities. In this farming system, livestock provides a mean for risk management during drought and crop failure period Rajaa, (2006).

2.2 Classification of animal feeds

Feedstuffs can be grouped into different classes on the basis of bulkiness (bulk density) and chemical composition. Feedstuffs are classified into roughages and concentrates based on the crude fiber (CF) content which is primarily responsible for the bulk density of the feed. (Abuswar, 2005).

The main animal feed resources available in the Sudan are range pasture, irrigated green fodders, agro-industrial by-products and grains. These resources avail in total about 104 million tons of dry matter to the national herd which requirements are estimated at 213 million tons (Abuswar, 2005) For ruminant species these feed resources are categorized as roughages and concentrates.

2.2.1 Roughages

Roughages as described by Kellems *et al* (1998) are plant materials primarily provide a dietary carbohydrates source for herbivores animals and are commonly referred to as forages or roughages. Forage is defined according to the same authors as the total plant material available to be consumed by an animal. Roughage is a term most often used by animal feeders and nutritionists to describe those dietary components that are characterized by being high in fiber (cellulose).Roughages as bulky feeds, high in fiber and low in energy. Cheeke (2005). The nutrients in roughages are made available primarily by microbial digestion either in the rumen or in the hindgut of non-ruminants. Kellemes and Church

(1998) stated that, the terms forages and roughages are often used interchangeably to describe plant materials that are relatively high in structural carbohydrates, which contain high amounts of cellulose and hemicelluloses. Ribeiro *et al* (2000) reported that, roughages are poor in digestive nutrients such as nitrogen and non – structural carbohydrates which are present at low concentration. They are poorly digestible due to presence of lignin and polyphenols. Feedstuffs classified as roughages have a high crude fiber (CF) content, and the digestibility of protein and energy, is generally lower. The National Research Council (NRC 1989) uses the following criteria to classify a feedstuff as roughage: When it contains greater than 18% crude fiber (CF) and less than 70% total digestible nutrients (TDN). Later, Reddy (2004) reported that, roughages are classified into succulent roughages (those which contain more than 80% moisture) and non-succulent; leguminous and non leguminous; green and dry. Roughages can also be grouped based on their nutritive value into maintenance type, productive type and non maintenance type:

1. Maintenance type of roughages have about 3 – 5% digestible crude protein (DCP) e.g. (cereal fodder, grasses and hay).

2. Productive type have more than 5% DCP e.g. legume fodder and their hay.

3. Non-maintenance type of roughages have below 3% DCP e.g. straws, Stover and sugarcane baggase.

2.2.2 Concentrate

Concentrate are feeds that are high in nitrogen free extract (NFE) and total digestible nutrients (TDN) and low in crude fiber (less than 18%). These feeds can be either high or low in protein content, e.g. cereal grains, oil meals and byproducts of milling industry

(Ensminger *et al.*, 1990). Concentrates, according to Reddy (2004); Cheeke (2005; and Kellemes and Church (1998) are further classified into 3 groups based on energy and digestible crude protein (DCP): carbonaceous-rich in energy and low in DCP (cereal grains), proteinous-very rich in DCP (oilseed meals and cakes, animal protein supplement) and products with energy and protein in intermediary position (bran, husks). Broadly feeds and fodders can be classified into roughages, concentrates and feed additives (nutritive and non-nutritive).

2.3 Animal feed resources

The main animal feed resources are:

- Natural grasslands (permanent pastures).
- Planted established pasture (forage crops, either rain fed or irrigated).
- Crop residues.
- Agro-industrial byproducts (sugarcane industry byproducts, oil cakes, milling byproducts).
- Manufactured animal feed (animal feed industry). (Izeldin, 2008).

2.4. Animal feed resources in Sudan

In Sudan livestock obtain feed from:

1. Grazing and browsing on natural pastures.
2. Crop residues and agro-industrial byproducts.
3. Cultivated pastures and forage crops. (Izeldin, 2008).

2.4.1 Natural rangelands

The availability and quality of native rangelands available to livestock vary with altitude, rainfall, soil type and cropping intensity. Total range area in Sudan is 279 million feddan. The productivity of this area is estimated as 78 million tons of dry matter (DM) and constitutes about 87% of the animal feed resources (AOAD, 2001). This feed resource is not enough to supply nutrients required by 65 million livestock units (LU), (1 LU is equivalent to a 250 kg animal), available in the country. This shortage is due to deterioration of grasslands particularly in the semi-desert and low rainfall savannah regions, expansion of agricultural mechanized schemes and destruction of pastoral resources through fire and overgrazing (Abu Swar and Darag, 2002).

2.4.2 Irrigated fodder

The irrigated fodder constitutes about 5% of the feed resources. This area yields about 4 million tons of dry matter (DM) that represent 4.36% of the total dry matter produced in Sudan (Abu Swar and Darag, 2002). The irrigated fodders in Sudan are alfalfa (94%), Abu 70 (5%), *phelebsera, doliches lablab* and *clitoria,* all together represent 1% (National Comprehensive Strategy, NCS, (1992).

2.4.3 Crop residues

Crop residues are produced in abundance. They include cereal straw (sorghum, wheat and millet straws), sugarcane byproducts (sugarcane tops) groundnut and cotton byproducts. Crop residues according to Abu Swar and Darag (2002) yield about 22 million tons of dry matter. In spite of the availability of these byproducts in Sudan, they are not fully utilized. Crop residues and agricultural byproducts could be used as an alternative animal feed. However the energy content of these byproducts is poorly utilized by rumen microbes due to the presence of the lignocellulosic components which are either indigestible lignin or acting as a barrier between the potentially digestible fraction (cellulose and hemicelluloses) and the digestible enzyme (McDonald *et al.*, 2002). Recently, the enzyme lignose is produced from fungi and yeasts in abundance, this provide the evidence for the feasibility of developing a composite microbial system with high capability of degrading straw lignocelluloses in order to make reasonable use of straw resources as reported by Zhang *et al.* (2004).

2.4.3.1 Sorghum:

Several commercial seed companies offer these warm season forages. Forage sorghum and sorghum- Sudan yield well and are usually ensiled, as stems are thick and cure slowly when windrowed. Nutritional value varies greatly with maturity. Late-harvested sorghum and sorghum-Sudan are similar in composition to corn Stover. Vegetative sorghum-Sudan and Sudan grass are good protein and energy sources. Sudan grass hay cut in the vegetative state has nutritional values similar to good-quality grass hay. Prussic acid and nitrate poisoning are potential problems. Haying the crop will reduce prussic acid problems, and ensiling the crop will reduce prussic acid and nitrate risks.

Generally, when the green plant is hit with a killing frost it is advisable to remove grazing cattle until the plant has dried, during which time the prussic acid in the plant volatilizes. Dried plants normally contain very little prussic acid, but monitor cattle closely the first few days after turning them back into the field. The problem develops when the plant is not completely killed by the frost. If the weather turns warm and the plants start to re growth, pull the cattle out until another killing frost dries the plants. Prussic acid (cyanide) poisoning is very rapid and clinical signs last only minutes before the animal dies. Signs of poisoning are nervousness, abnormal breathing, generalized muscle tremors, gasping for breath and convulsions. Distinguishing characteristics are bright and cherry red color of the blood. There is no known treatment. (Greg *et al*, 2003).

2.4.3. 2 Groundnut straw:

The ground nut straw represents the residues of the plant after harvesting the pods. The straw comprises 42% of the plant weight .average production of ground nuts straw is estimated to be 336 thousand tons annually in Sudan (ACSAD, and AOAD 1981).

2.4.3. 3 Nutritive value:

Ground nut straw is one of the best agricultural by products in it is nutritive value. It is extensively used for all classes of livestock. The straw has (on DM basis) 9% of crud protein and 61% TDN (ACSAD, and AOAD 1981).

2.4.3.4 Sesame straw:

Sesame crop residues are by-products left after the seeds are collected. It contains seed capsule, leaves and stems. The residues are usually burned out in the field in order to clear and clean the land from possible pest infestation hazard in the residues.

The residues are likely to harbor insects harmful to growing sesame plant.

Sesame as an oil seed crop in Sudan is considered as a cash food crop of significant importance.

2.4.4 Agro-industrial residues

The agro-industrial residues are fibrous materials termed (byproducts) when a profitable use is made out of them, otherwise termed (waste products). The increase in sorghum straw prices together with the decreased productivity of rangelands and limited forage production have increased the importance of these byproducts (particularly baggase) for ruminants feeding as a source of fiber instead of the expensive sorghum straw. (Barreveld, 1982).

2.4.5. Sugarcane industry byproducts

2.4.5.1 Sugarcane baggase (SCB)

Sugarcane baggase (SCB) is a fibrous material left over in sugar factories after extraction of all the juice from sugarcane (Reddy, 2004). It is cheap agro-industrial by-products. Ensminger *et al*. (1990) reported that, baggase is high in fiber. It has a low dry matter digestibility – only about 25%. Additionally, its TDN is extremely low, ranging from 20 – 35%. However, baggase has been used effectively as a carrier of molasses, the combination of which yields a relatively high fiber, high energy yield.

Abu Swar and Darag (2002) reported that baggase forms about 43.4 – 48.7% of the total weight of the refined sugarcane. The chemical analysis of baggase reveals 47.9% CF and 1.72 MJ/kg DM metabolizable energy (ME).

2.4.5. 2 Molasses

Molasses is a product of the sugar-refining industry. The principal types are cane and beet molasses refined from sugarcane and sugar beets, respectively. They are similar in composition and feeding value. McDonalds *et al.* (2002) reported that sugarcane (*Saccarum officinarum*) is produced in tropical and subtropical regions. Sugar-cane is a perennial grass, with thick - sugar rich stems and abundant leaves. The cane is harvested when sugar content is at a maximum and transported to the refining plant. The stems are pressed to squeeze out the juice, containing the sugar. The fibrous residue of the stalk is called (baggase) which is burned or used as low quality roughage for animal feed. The juice is concentrated by boiling, and then sugar crystallizes out of the concentrated juice and is collected as raw sugar. The juice residue is the molasses. From each ton of sugarcane approximately 100 kg of refined sugar and 25 – 50 kg of molasses are produced (McDonald *et al.*, 2002). Liquid molasses contains 15 – 25% water. It is black, syrupy sweet solution containing at least 46% sugars. It can be dried to produce dried molasses, but the added cost usually does not warrant drying. It is very low in protein content. Molasses functions primarily as an energy source and can be fed at levels up to 30 percent of the diet. El Khidir *et al.* (1995) had reached up to 52% of the diet successfully in feeding Sudan Baggara bulls. At higher levels, it has a laxative property because of its high mineral content (particularly potassium). Bayley *et al.* (1983) fed cane molasses at 68.5 percent of the diet of pigs, as the sole source of dietary carbohydrates, the faeces were black and liquid, but there were no more other adverse effect.

Table (1) Baggase production in Sudan (tones).

	2000-2001	2001-2002	2002-2003
Kenana	78,594	31,885	31,000
Elgeneid	332,444	387,298	352,000
Halfa	360,612	350,000	350,000
Sennar	265,393	320,809	368,000
Assalaya	245,770	264,688	288,000
Total			1,391,600

Source: Abu Swar and Darag (2002).

Molasses is often included in manufactured feeds at levels of 2-5 percent to increase palatability. McDonald *et al*. (2002) described the advantages of this as reducing the dustiness and "fines" and acts as pellet binder to improve pellet quality. At levels above 5 to 10 percent it may cause milling problems because of stickiness and may form large clumps in the mixture or stick to the equipment in the feed mill.

There is much interest in the tropics in developing beef production systems based on molasses feeding. In sugar producing countries like Sudan, there are large quantities of molasses available. The high energy feed is not utilized directly by animals in large amounts. In Cuba for instance, intensive beef production has been developed on a molasses-urea based diets. Molasses provides the major source of fermentable carbohydrates and urea provides fermentable nitrogen, a roughage source such as sugarcane tops (SCT) or sugarcane baggase (SCB) is used to provide sufficient fiber to maintain normal rumen function. Protein-rich legume forage such as leucaena, may be used of both roughage and bypass protein (Cheeke, 2005). Five sugar factories were found in Sudan. They produced about 1.160,000 tons of molasses during 2002 – 2003. Ninety six percent of this amount is exported and only 4% is available for the country consumption (Abuswar and Darag, 2002).On the other hand, Darag *et al.* (1995) reported that, the amount of molasses produced in Sudan could maintain 1.1 million Animal Unit (AU) for three months during critical periods.

2.4.5.3 Molasses toxicity

In molasses-based feeding systems, a problem referred to "molasses toxicity" may develop, characterized by neurological defects such as in-coordination and blindness. Molasses toxicity has a complicated etiology and involves an inadequate supply of glucose to the brain inducing thiamine deficiency and rumen stasis. (McDonald *et al*., 2002).

Inadequate glucose status occurs because molasses fermentation produces a high rate of butyrate to propionate as end products. Butyrate is ketogenic and propionate is glycogenic. An excess of butyrate relative to propionate results in inadequate glucose synthesis and shortage of glucose for brain metabolism. Molasses toxicity occurs when the roughage component of the diet is insufficient. Low fiber intake results in rumen stasis and proliferation of slow-growing microbes. Provision of adequate roughage is effective in preventing molasses toxicity (McDonald *et al*., 2002).

2. 5 Concentrates (energy sources)

2. 5.1 Sorghum grains

Sorghum and millets are the major food grains in the semiarid tropics, an ecological zone encircling the globe and including China, India, most of Africa, Australia, Argentina and parts of Southern United States. In the developed countries approximately 96% of the total sorghum and millet grown is used for animal feed, where in the developing countries, only 8% of these crops is used for livestock (Cheeke, 2005), with the rest 92% used directly as human food. In the Sahelian zone of Africa, approximately 90% of the rural population depends on these crops as their major source of food. Sorghum is hardy, drought resistant crop adapted to environmental conditions too harsh to production of other cereals. However there is a considerable variability in feeding values among sorghum cultivars and types, mainly because of variation in tannin content and seed coat color-brown-high tannin, bird resistant sorghum give poorer animal performance and lower digestibility than low tannin type. Sorghum is a fairly poor protein source (7-10%)

according to Cheeke (2005) with low availability of amino acids. Sorghum protein digestibility is fairly affected by tannin (Streeter et *al*., 1993) sorghum like other grains has very low calcium, high phosphorus phytate and no vitamin B_{12}.

2. 5 .2 Cereal milling byproducts

2. 5.2.1 Wheat bran

In wheat milling, the endosperm is separated from other fractions of the seed. The endosperm consists mainly of starch and gluten. The outer most layer of the seed is highest in fiber and when removed constitutes most of the bran fraction (Cheeke, 2005). Wheat bran consists of the outer most layers of the seed along with some flour. It is a flaky, reddish brown material. Wheat bran is quite palatable and is well known for its ability to prevent constipation because of its swelling and water holding capacity. Ellis (1981) reported that, the wheat bran of 93.5% DM contain a metabolizable energy (ME) of 10.10 MJ/kg DM and 16.83% crude protein (CP), on the other hand Cheeke (2005), reported 13.5 - 15% CP for the wheat bran. In Sudan, Darag *et al*. (1995) estimated the annual production of wheat bran as 285.420 ton/year, 7 out of 16 flour mills is working and all were located in Khartoum State (Abu Swar and Darag, 2002).

2. 6 Concentrates (protein sources)

2. 6.1. Groundnut cakes

Oilseed cakes and meals are byproducts of vegetable oil production for edible and industrial purposes. In some countries groundnut is called peanuts (*Arachis hypogoae*), it is grown for human consumption and oil extraction. Principal producers are India, China, Nigeria, the United States and Brazil (Cheeke, 2005). Groundnuts are annual legumes, produced mainly in tropical and semi-tropical environment. In Sudan it is also produced as nuts and oil for human consumption or groundnut cakes as an animal feed, it is produced in underground pods. Groundnut meal contains approximately 45 to 50% crude protein (CP), and is quite deficient in lysine (Cheeke, 2005) and suboptimal amounts of cystine and methionine (McDonalds *et al*., 2002). The latter authors also reported that groundnut meal is now usually made from the pods used as a feed source, when an un-decorticated meal is produced. Ellis (1981) estimated 43% (CP), 12.68% (CF) and 11.57% MJ/kg (ME) for the mechanically extracted decorticated groundnut cake. Ørskov and Macleod (1982) reported higher degradability values for groundnut cakes compared to linseed meal and fish meal. Groundnut cake contains low amounts of crude fiber (CF) which make it unsuitable alone for feeding ruminants (Abu Swar and Darag, 2002).

2.7 Animal feed industry

According to the FAO (2004) there are three definitions for animal feed industry, one of them is "commercial operations producing feed for sale", the second one is "integrated operations where large producers in particularly produce their own feedstuff" and the third definition for animal feed industry is "the cooperative operations where farmers jointly own the feed mill or production plant that produce the feed they use". On the other hand Cheeke (2005) uses the term animal feed manufacturing rather than animal feed industry and defined it as the process of converting ingredients raw materials "feedstuffs" into balanced diets that are then sold to producers of livestock and other animals. In many countries the term "feed compounding" and "compound feeds" are used.

Manufactured feeds are produced in feed mill that have equipments to process feedstuff "e.g. grinding and extruding" for mixing in the desired proportions and for mixing the ingredients to produce the finished product (Cheeke, 2005), often the mixed feed is pelleted, or it may be marketed as a meal type "mash feed".

Beef cattle and sheep are primarily grazing animals and generally receive little if any manufactured feed. Feedlot cattle are usually fed diets mixed at the feedlot and so are not major consumers of manufactured feed (Cheeke, 2005). The same author reported that, modern feed mills are largely computer controlled. The process begins with company nutritionist who computer formulate diets, using NRC (National Research Council) or other recognized requirement figures, tables of feed composition and current prices of ingredients. Many diets are least cost formulas, in which the ingredients are selected to meet the prescribed nutrients requirements figures at the lowest cost. There may be factors, such as palatability and physical texture that reduce animal performance. According to the FAO (2004).

Ensminger *et al.* (1990) defined animal feed industry as the operations necessary to achieve the maximum potential nutritional value of feedstuffs, i.e. changing ingredients in such a manner as to maximize their natural value and the net returns from their use. The latter author also tends to use the term "feed processing" as a synonymous to feed industry which may be physical and/or chemical.

Similarly, Church *et al.* (1998) described animal feed industry as methods which might involve mechanical, chemical and/or thermal methods or combination of all of these methods to alter the physical form or particle size, to prevent spoilage, to isolate specific parts of the seed or plant, to improve palatability, or to inactivate toxins or anti-nutritional factors of one type or another.

2.8 Feedlot performance

Feedlot performance as a fattening process is expressed in terms of dry matter intake (DMI) per day, body weight gain per day and the feed conversion ratio. (McDonald *et al*., 2002).

2.9 Voluntary feed intake

Feeding is a complex activity which includes such action as the search for food, recognition of food and movement towards it, sensory appraisal of food, and the initiation of eating and ingestion (McDonald *et al*., 2002). Voluntary feed intake is the main factor which determines animal productivity; and this intake will be a reflection of the chemical composition, physical characteristics, digestion and the rate of passage of the diet through the digestive system (Welch, 1982).

2.9.1 Control of voluntary feed intake

Forbes (1996) concluded that, the control of voluntary feed intake by ruminants has been studied by many research groups over the past 40 years, using a wide variety of techniques. Over this period several theories have been proposed, each based on a particular factor. For example observation that forage intake is often positively related to the rate or extent of digestion in the rumen led to the physical theory which has been supported both by the discovery of receptors in the rumen wall sensitive to stretch and touch and by the fact that intake is depressed when the capacity of the rumen is reduced (Allen, 1996). Another theory is that concentration and flow of nutrients and energy, including volatile fatty acids (VFA) produced by fermentation in the rumen, are involved in controlling intake (Illius and Jessop, 1996). Most authors have accepted that the factor they studied was just one of many possible and interacting factors and this means that the effects of these signals are additive (Forbes, 1996, 1980b).

2.9.2 Factors affecting feed intake

Cheeke (2005) summarized these factors affecting feed intake as palatability and feed preference, secondary compounds , dietary energy level, protein and amino acids concentration, forage composition, environmental temperature, pregnancy and lactation in females, metabolic body size, and learning and conditioning, as the major factors, other factors like smell of the diet, fatigue and rumination time are also considered as reported by Preston and Leng (1987); Mclea and Smith (1989); Vastest (1994). Palatability is a determinant of feed intake. Palatability is the summation of the taste, olfactory and textural characteristics of the feedstuff that determines its degree of acceptance. McDonald *et al*. (2002) had reported that mechanical grinding of roughages and pelleting partially destroys the structural organization of the cell wall, thereby accelerating their breakdown in the rumen and increasing feed intake. They studied the relationship between the digestibility of feed and their intake and found a positive relationship between them. Similar results were obtained by Lippke (1986) that cattle select a diet that maximize digestible organic matter intake and he concluded that, forage intake in cattle is regulated by the indigestible NDF. General conclusions from studies of chewing time in cattle included a positive relationship between time spent chewing and increased particle size in the diet and increase dietary concentration of NDF (Sudweeks *et al*., 1975, 1981; Woodford and Murphy, 1988). Chewing time/kg of DMI decrease as DMI increase (Sudweeks *et al*., 1980; Beauchemin and Buchanan-Smith, 1996; Loginbuhl *et al*., 2000). Animals often exhibit a reluctance to accept a new feed (Cheeke, 2005). Similar conclusion was achieved by Chapple *et al*. (1987) who found that it took sheep several weeks to overcome fear of the feed trough and supplementary wheat, and then a period was needed to learn to eat, chew and swallow wheat. The learning process was accelerated if there were some experienced animals in the flock. Huntington and Burns (2007) had studied voluntary feed intake of gama grass and switch grass balege by seers, they had concluded that reduced DMI was attributed in part, to the 'steers' behavior, this might give the individuality of animals behavior some importance in affecting voluntary feed intake.

2.9.3 Feed conversion ratio (FCR)

Feed conversion ratio is also known as efficiency of feed utilization (Izeldin, 2008). It is defined as the amount of feed required to produce one unit of live weight gain. Since feed affects total profits of beef cattle production as its' the major item of expense in finishing cattle. Ensminger (1990) reported that feed accounts for 70 – 80% of the cost of feedlot finishing exclusive of the purchase price of the animals. This explains the importance of FCR as an important ratio to assess. Levy et *al*. (1968) and Thiessen *et al*. (1984) observed that feed efficiency declines with the increase in live weight and duration of fattening. Reyneke (1976) in a comparative study on beef production from bulls, steers and heifers, concluded that bulls required 5.14 kg/DM/Kilogram live mass gain. Under feedlot conditions, Charolais and Hereford bulls kept on high molasses level required 5.6 and 6.4 kg dry matter per unit weight gain, respectively (Veitia *et al*., 1979). Cobic *et al*. (1980) reported that, the feed conversion was most efficient in animals fed the highest crude protein level (14.3 – 16.6%) in dry matter of the ration. Gaskin *et al*. (1982) studied the feed requirements for maintenance and gain in crossbred bulls of Jersey X Angus on concentrate diets. They found that the respective feed conversion ratio values were 4.7 to 7.2 kg/dry matter/kg live weight. Theissen *et al*. (1984) reported values ranging from 5.52 to 13.41 for Dexter and British Charolais breeds fed standard pelleted diets.

Elshafie and Mcleroy (1964) investigated the response of Sudan Baggara cattle to a fattening ration composed of agricultural byproducts. They found that the feed conversion ratios were 6.5, 7.9 and 9.2 kg DM/unit live weight gain for age groups ranging from yearlings to three years old.

2.10 Energy requirements

Ruminants need energy for their life processes. As far as the diet is concerned it is best to consider the useful energy rather than the total or gross energy (GE) (Owen, 1979).

Expressing energy requirement and energy values of feedstuffs for ruminants is somewhat more complex because of rumen fermentation and the complexity of interaction between diet and fermentation and products. One example of this complexity is the effect of balance of absorbed VFA on metabolic efficiency if there is a surplus of acetate (C_2) or a deficiency of propionate (C_3), the C_2 energy cannot be utilized in the citric acid cycle reactions of metabolism (Cheeke, 2005).

McDonalds *et al*. (1987) reported that faster growing cattle have gains of higher energy concentration; for example 300-kg steers of a medium-sized breed growing at 1 kg/day retain 15.5 MJ/kg, whereas the same animals growing at only 0.5 kg/day retain only 14.3 MJ/kg. The influence of breed is a reflection of mature size, the sex of the breed is also considered having an effect on energy requirements e.g. the gains of heifers have a higher concentration of energy than those of steers, and the gains of steers have a higher concentration than those of bulls.

2.11 Protein requirements

The latest version of the Nutrient Requirements of Beef Cattle (NRC, 1996) uses metabolizable protein (MP) system to calculate protein requirements. Practical diets for growing and finishing cattle typically are formulated on the basis of percentage of CP, with little efforts to consider ruminal N transaction and/or the protein amino acid requirements of ruminants (Galyean, 1996). The minimum protein level giving maximum growth or nitrogen retention is taken as the estimate of the requirements (McDonald,et al, 1987). Kay and Maedearmid (1973) found no significant differences (P> 0.05) in live weight gain between bulls given diet containing 14.5 and 17% crude protein (CP). They concluded that where cereal diets were used to fatten bulls no improvement in weight gain was achieved by increasing CP content above 14.5% for bulls up to 250 kg (LWT) and subsequently above 12%. Similar findings were obtained by Cobic *et al* (1980). They added that for bulls up to 250 kg of live weight gain for satisfactory live weight gain and feed efficiency, the ration should contain at least 14% CP in DM, while about 12% CP could be sufficient up to 350 kg, which would be lowered to 10% in the final period of fattening. Similarly Galyean (1996) reported that, dietary CP level in beef finishing diets is typically 12.5% or greater. Kousgaard (1980) reported better daily gains in animals kept on higher protein level.

2.12 Minerals requirements

Calcium and phosphorus are the minerals required in greatest quantity by beef cattle (Cheeke, 2005). McDonalds *et al.* (1987) reported that, the net requirements of mineral elements for maintenance plus growth is calculated as the sum of the endogenous losses and the quantity retained. They concluded that, dietary requirements decline less with ages because the availability of these elements is reduced as the animal matures. It should be noted that within small ranges in weight mineral requirements are considered to be proportional to live weight, not to metabolic weight.

2.13 Vitamins requirements

The B-complex vitamins and vitamin K are usually synthesized in adequate amounts in the rumen and vitamin D is obtained with exposure to sunlight. Therefore, vitamin A and E are the major vitamins of concern (Cheeke, 2005). Requirements are often determined from diets containing synthetic sources of vitamins (McDonald *et al*., 1987).

2.14 Digestibility coefficient

Nutritional feed values are currently based on aggregate criteria such as fecal digestibility. Digestibility is the result of two competing processes: digestion and passage. In order to develop mechanistic model of digestion to be used for feed evaluation, both processes have to be quantified (Wilfart *et al*., 2007). The digestibility of feed is most accurately defined as that proportion which is not excreted in the faeces and which, is therefore, assumed to be absorbed by the animal. It is commonly expressed in terms of dry matter and as a percentage or a coefficient (McDonald *et al*., 2002). The same authors reported that, since the excretion in faeces of substances not arising directly from the feed, the values obtained in digestibility trials are therefore called apparent digestibility coefficients (ADC) to distinguish them from the coefficients to true digestibility coefficient (TDC) which are difficult to determine. Since the 1960s many pasture and range studies have coupled fecal output estimates with *in vitro* digestibility measurements to calculate intake (Cordova *et al.*,2001). However , several researchers have reported that *in vitro* estimates are unreliable estimates of *in vivo* digestibility because of associative effects (Mehrez *et al.*, 1983), level of intake effects (Van Soest, 1982), rate of passage differences (Ellis, 1978). Other less animal dependant techniques used to determine digestibility are, *in vitro* digestibility (Tilley and Terry, 1963), *in situ* degradability(Ørskov and McDonald, 1979); and gas production (Theodoron *et al.,(1994).*

2.14.1 Factors affecting digestibility

McDonald *et al*. (2002) reported many factors affecting the digestibility such as feed composition, ration composition, preparation of feed, and enzyme supplementation of feed, animal factors and level of feeding. These factors either overestimating or underestimating the apparent digestibility coefficient values. In the *in vivo* methods, the initial trial condition generally have a low weight because of the final results are a combination of the adaptation period and the observation period. The other methods can be influenced to variable degrees by the initial conditions (Aerts *et al.*, 1977 and Judkins *et al.*, 1990). The digestibility trials are often conducted with mixed diets because of the impossibility of having maintenance level (Pigden *et al.*, 1980).

Chapter Three

Materials and Methods

3. 1 Location:

The study was carried out at El Gadarif Livestock Research Station in Gedarif state is located in eastern Sudan, boarded by Kassala state to the north, Khartoum state to the northwest, Sinnar state to the south, Gezira state to the west Eretria and Ethiopia countries to the east. The state covers a total area of 75,263 Km^2. It lies between latitude 12^o 45 N and 14^o 15 N and longitude 34^o E and 37^o E, its average altitude is 600 meters above the sea level. Also, the region under consideration is about 490 km from the capital Khartoum and 770 km from Port Sudan city, the main sea port of Sudan. Annual rainfall averages between 400 – 600 mm, in a season extending from June to October. (Rajaa, 2006).

3. 2. The crop residues Description:

The crop residues under study were sorghum straw, sesame straw (stems & pods) and ground straw (leaves & stems), which it brought from the agriculture schemes in Gadarif State. About 200 kg of each crop residue were used to identify feed intake and digestibility trials using local sheep lambs.

3. 3. The Experimental Animals:

Nine experiment desert sheep lambs (8 – 12 month age), and 25 -36 Kg mean body weight brought from El Gadarif Animals market were used in the study. The animals were healthy; they were dosed with *Ivomic (MSD)* for internal parasites and sprayed with *Sypermethrine* (Jordon) for the control of external parasites, vitamins, and *oxytetracyclline* 5 ml / animal as protective dose .The animals were numbered and kept under full shade, in pen (1 m X 0.5 m.), roofed, with local materials sheets.

The animals were divided in to three groups each of three sheep lambs was assigned randomly to one of three equal groups with three animals in each group individually. The experimental design was complete randomized design (CRD). Each group contained three animals in three pens individually. Pens were used as the experimental unit for feed performance data. Pens were (1 x 0.5) m. Animal groups were randomly allotted to one of three dietary-treatment groups in a factorial arrangement of three diets (sorghum straw, sesame straw and ground straw) Fed according to the average weight (500 ±5 g / animal) on three experimental diets.

A = Sheep fed sorghum straw.

B =. Sheep fed groundnut straw.

C = Sheep fed sesame straw.

The diets were fed individually in a changeover design, periods of three weeks.

Fourteen days were allowed as changes over period between treatments before measurement were taken. The diets were fed *ad lipitum*, individual and feed were measured weekly from daily data.

Clean water was provided in suitable throughs, available all time. Lick stones were available in pens.

The sheep lambs were weighed in a weighing crush weekly. The weight was recorded to nearest Kilograms; it was taken at the beginning and the end of experimental period.

3. 4. Experimental Diets:

A= Sorghum straw.

B= Groundnut straw

C =sesame straw.

3. 5. Collection Periods (Digestibility Trial):

Three days before the beginning of the collection zipped canvases bags were attached to webbing harness of the sheep in order to measure the digestibility trails. The collection period was extended to 21 days. Feaces were collected every morning and transferred quickly to determine the dry matter by using dry oven at 70-80 ºC.

Accumulated daily samples from each animal (Accumulated) were pooled together in container to taken for chemical analysis.

3. 5.1. Calculation of Digestibility

The digestibility was calculated as follows:

$$\textbf{DDM} = \frac{\text{DM intake (g)} - \text{faecal output (g) DM} \times 100}{\text{DM intake (g).}}$$

$$\textbf{DCP} = \frac{\text{CP intake g/d} - \text{faecal output C.P g/d} \times 100}{\text{C.P intake g/d}}$$

$$\textbf{DEE} = \frac{\text{EE intake g/d} - \text{faecal EE g/d} \times 100}{\text{EE intake g/d}}$$

$$\textbf{DCF} = \frac{\text{C.F intake g/d} - \text{faecal C.F g/d} \times 100}{\text{C.F intake g/d}}$$

3. 6. Chemical Analysis:

The samples of feed collected during the experiments were analyzed for their proximate components, and the samples of faeces were analyzed for acid insoluble ash. The methods used were those of A.O.A.C (2000).

3. 7. Statistical Design and Data Analysis:

The analysis of variance was used in this study. Dry matter intake, crude protein intake weights growth performance data were statistically analyzed by the general linear models procedures of SAS one factor.

The least significant differences (LSD) multiple range tested was used to tests for significant between means.

Chapter Four
The Results

4. 1 Experiment (1): Comparison of the chemical composition of experimental diets:

Table (1) shows that, there were a significant ($P < 0.05$)variation in dry matter DM in chemical composition analysis between the three experimental diets, T1 (sorghum straw), T2 (groundnut straw) T3 (Sesame straw) (A, C, B) respectively . the least significant difference (LSD) between the three treatments was (0.0006318).

Crude protein CP analysis in the same table shows that, there were a significant ($P < 0.05$) difference between the three treatments, the most difference obsesrve in T2 (groundnut straw) then T1 (sorghum straw) and the lowest one was T3 (sesame straw) (B, A, C) the least significant difference (LSD) between the three treatments was (0.0006318).

In crud fiber CF analysis the table indicate that, there were a significant difference between the three treatments ($P < 0.05$), the most difference take place in T3 (sesame straw) then T1 (sorghum straw) and the lowest one was T2 (groundnut straw) (C, A, B).the least significant difference (LSD) between the three treatments was (0.0006318).

Ether extract EE in the three treatments the same table indicated that a significant($P < 0.05$) difference take place in, the highly one occurred in T2 (groundnut straw), the second was T1 (sorghum straw) and the lowest was in T3 (sesame straw), the least significant difference (LSD) between the three treatments was (0.0006318).

For Ash in the chemical composition analysis between the three treatments, the table appearance that there was a significant(P < 0.05) difference between treatments. Highest significant in T2 (groundnut straw) then T1 (sorghum straw) and the last T3 (sesame straw) (B, A, C). The least significant difference (LSD) between the three treatments was (0.0006318).

Table 1. Analysis of variance of chemical composition of the experiment feed

Treatment	DM	CP	CF	EE	ASH
A	96.70 ^{a} ± 0.00	5.50 b ± 0.00	40.00 b ± 0.00	0.80 b ± 0.00	8.28 b ± 0.00
B	95.50 c ± 0.00	9.91 ^{a} ± 0.00	26.00 c ± 0.00	1.60 ^{a} ± 0.00	11.83 ^{a} ± 0.00
C	96.60 b ± 0.00	4.31 c ± 0.00	56.00 ^{a} ± 0.00	0.40 c ± 0.00	6.11 c ± 0.00
C.V%	0 .0 %	0.0 %	0.0%	0.0%	0.0 %
LSD 0.05	0.0006318*	0.0006318*	0.0006318*	0.0006318*	0.0006318*
SE	0.0001826	0.0001826	0.0001826	0.0001826	0.0001826

A = Sorghum straw.

B = Groundnut straw.

C = Sesame straw.

SE standard error of difference between any two means

a, b, c means the same column with different superscript are different significantly (P>0.05).

C.V= coefficiant variation

LSD= the least significant difference (P< 0.05).

* = significant difference

** = Highly significant

4. 2 Experiment (2): The dry matter intake DMI, crude protein intake CPI , crude fiber intake CFI Ether extract and Ash intake

According to the data in table (2) in dry matter intake DMI, there were significant difference between T1 (sorghum straw) and T2 (ground nut straw) ($P < 0.05$) and T2 and T3 (sesame straw) ($P < 0.05$), but the same table indicated that there was no significant difference between T1 and T3 ($P< 0.05$). The Least significant difference (LSD) between T2, T1 and T3 was (0.0006318).

For the crude protein intake CPI, table (2) reflected that, there were significant ($P < 0.05$) difference between T1 (sorghum straw) and T2 (groundnut straw) and T2 and T3 (sesame straw) ($P < 0.05$), but the same table indicate that there was no significant difference between T1 and T3 ($P< 0.05$). The Least significant difference (LSD) between T2, T1 and T3 was (151.5).

As for crude fiber intake CFI, the table illustrated that, there were significant ($P < 0.05$) difference between T3 (sesame straw) and T1 (sorghum straw) and T3 and T2 (groundnut straw), but the same table indicated that there was no significant difference between T1 and T2 ($P< 0.05$). The Least significant difference (LSD) between T2, T1 and T3 was (1233.00).

For ether extract intake EEI, the table showed that, there were significant difference between the treatments T2 (groundnut straw), T1 (Sorghum straw) and T3 (sesame straw) (b, a, c) respectively ($P < 0.05$) (LSD) between T2, T1 and T3 was (10.59).

Also for Ash intake the table showed that there were a significant ($P < 0.05$) difference between the three treatments T2 (groundnut straw), T1 (sorghum straw) and T3 (sesame straw) (B, A, C) respectively (LSD) between T2, T1 and T3 was (39.25).

Table 2. Analysis of variance of feed intake:

Tret	DMI	CPI	CFI	EEI	ASH I
T1	9020.00c ± 210.50	513.10b ± 11.99	3731.00b± 87.08	74.63b ± 1.72	772.33b±18.01
T2	11560.00 ^{a} ±288.23	1163.00^{a} ± 29.89	3148.00 c ± 78.46	193.70^{a} ± 4.85	1465.63^{a} ± 27.76
T3	9359.00 b ±1825.00	417.90 c ± 81.84	5426.00^{a} ±1051.27	38.77 c ± 7.60	723.50 c ± 7.92
C.V	10.80 %	7.27 %	15.05 %	5.18 %	1.99 %
LSD	0.0006318*	151.5*	1233.00*	10.59*	39.25*
SE ±	0.0001826	29.32	356.4	3.06	11.34

T1 = Sorghum straw.

T2 = Groundnut straw.

T3 = Sesame straw.

SE standard error of difference between any two means

a, b, c means the same column with different superscript are different significantly (P>0.05).

C.V= coefficient varriation

LSD= the least significant difference (P< 0.05).

* = significant difference

** = Highly significant

ns = non significant.

4. 3 Experiment (3): The digestibility of dry matter DDM, crud protein DCP, crud fiber DCF ether extract DEE and ash digestibility:

For the digestibility trails, table (3) indicated that the digestibility of three treatments in dry matter, crud protein and crud fiber.

For dry matter digestibility DMD the table showed that, there was a significant differences between T1 (sorghum straw) and T2 (groundnut straw) (P < 0.05), and between T1 and T3 (sesame straw) (P<0.0.5), but table indicate as the same time, there was no significant diffrence between T2 and T3. The least significant difference LSD (833.90).

For crud protein digestibility DCP the table showed that, there were a significant differences between the treatments T2 (groundnut straw) and treatment T1 (sorghum straw) and T3 (sesame straw) ($P < 0.05$), LSD (22.47), but there were no significant difference between T1 and T3 ($P<0.05$).

Crude fiber digestibility CFD, table (3) illustrated that, there were no significant($P < 0.05$), differences between T1 (sorghum straw) and T2 (groundnut straw) but the significant difference was observed between T1 and T3 (sesame straw) (P<0.0.5), and T 2 and T3 ($P< 0.05$). The least significant difference LSD (516.1).

Ether extract digestibility EED, table (3) indicated that, there were no significant differences between the three treatments in the digestibility experiments T1 (sorghum straw), T2 (ground nut straw) and T3 (sesame straw) ($P < 0.05$).

Ash digestibility, table (3) indicated that, there were no significant differences between the three treatments in the digestibility experiments T1 (sorghum straw), T2 (groundnut straw) and T3 (sesame straw)

Table 3. Analysis of variance of digestibility trails:

Tret	DDM	DCP	DCF	DEE	D Ash
T1	33.17c ± 3.17	24.27b ± 9.42	27.70 b ±7.96	26.60 c ± 21.77	39.87 ^{a} ±13.83
T2	45.97 ^{a}b ± 4.69	47.10a ± 14.1	18.23 c ± 11.52	36.13b ± 32.83	8.20 c ± 7.13
T3	50.07 ^{a} ± 10.91	19.30c ± 9.72	49.90 ^{a} ± 10.83	60.67 ^{a} ± 37.96	33.87 b ± 22.38
C.V	16.48 %	37.21 %	31.99 %	76.79 %	57.62 %
LSD	14.48 *	22.47 *	20.42*	63.11^{ns}	31.44 ^{ns}
SE ±	4.097	6.493	5.90	18.24	9.09

T1 = Sorghum straw.

T2 = Groundnut straw.

T3 = Sesame straw.

SE standard error of difference between any two means

a, b, c means the same column with different superscript are different significantly (P >0.05).

C.V= coefficient variation

LSD= the least significant difference (P < 0.05).

* = significant difference

** = Highly significant

ns = non significant

4. 4 Experiment (4): analysis of variance of body weight change (Kg)

It was clear that from table (4), there were no significant (P < 0.05) differences between the three treatments in body weight change A (lamb fed sorghum straw), B (lambs fed groundnut straw) or C (lambs fed sesame straw).

Table 4. Analysis of variance of body weight change

Treatments	Start weight (kg)	Weeks		
		1	2	3
A	29.33 ^{a} ± 0.14	29.00 ^{a} ± 0.12	28.33 ^{a} ± 10	28.33 ^{a} ± 10
B	30.67 ^{a} ± 0.18	29.67 ^{a} ± 0.17	29.33 ^{a} ± 0.14	30.33 ^{a} ± 0.16
C	29.33 ^{a} ± 0.14	29.33 ^{a} ± 0.14	29.67 ^{a} ± 0.17	28. 67 ^{a} ± 0.11
C.V	21.24 %			
LSD	10.50 ^{ns}			
SE	3.597			

A = lambs fed sorghum straw.
B = lambs fed groundnut straw.
C = lambs fed sesame straw.
SE standard error of difference between any two means
a, b, c means the same column with different superscript are different significantly (P>0.05).
C.V= coefficent varriation
LSD= the least significant difference (P< 0.05).
* = significant difference
** = Highly significant
ns = non significant

Table blow indicate the correlation (r) between the body weight BW vs crud protein intake CPI , body weight vs dry matter intake DMI and dry matter intake DMI vs. crud protein intake CPI:

	BW	**DMI**	**CPI**
BW	1	0.374w	0.594*
DMI	0.374w	1	0.633**
CPI	0.594*	0.633**	1

w = weak relationship.

* = moderate relationship.

** = strong relationship.

Chapter Five
Discussion

This study was carried out a part of the Gadarif state strategy to improve animal available feed resources and to fill the significant gab in feed stuff in the dry season for the domestic animals.

The main objective of the study is to furnish basic information on the nutritive value of the most common and available crop residues (Sorghum, groundnut and sesame straw) which naturally cultivated in a very large scale in the rain fed mechanized or traditional areas in the state, and that to main objectives to utilize the crop residues in the dry season to feed livestock.

Chemical analysis of crop residues

Crop residues under study with low crud protein CP, sorghum straw (5.5 % CP) groundnut straw (9.9 % CP) and sesame straw (4.3 % CP) content like other roughages is characterized nutritionally by low intake and low digestibility. Low nitrogen content which was below recommended nitrogen concentration for ruminant feeds (13% C.P DM) suggested by Salter and Roffler (1975). This concentration was assumed to produce ammonia – N concentration. The rumen equal to 50mg N/L rumen fluid Satter and Slyter (1974) thus providing for optimum remind environment for maximum microbial feed fermentation and digestion, as well as more feed intake Weston (1974).

Panigrahi *et al* (1995) stated that Fibrous crop residues, although inherently of low nutritive value, are of particular importance as sources of nourishment for ruminant livestock in the dry season. Same result observed by (Cheek, 2005) who described roughages as bulky feeds, high in fiber and low in energy.

Feed intake

Crop residues according to Abu Swar and Darag (2002) yield about 22 million tons of dry matter. In spite of the availability of these byproducts in Sudan, they are not fully utilized.The quality of various crop residues is determined by the protein and energy or digestible dry matter (DDM) content of the particular residue, because these are the nutrients most important to livestock performance. (Shanhan, *et al* 1998).

As mentioned in table (2) in this study, sorghum straw scoured the medium level in dry matter intake DMI and crud protein intake CPI thus in crude fiber intake CFI.

As reported by Cheeke (2005), Sorghum is a fairly poor protein source (7-10%) with low availability of amino acids.

Groundnut straw was scoured the high level in dry matter intake DMI and crud protein intake lower level in crud fiber intake CFI. (Nagaraj 1988) reported that, groundnut haulm is a nutritious feed for cattle. It contains protein (8-15%), lipids (1-3%), minerals (9-17%), and carbohydrate (38-45%) at levels higher than cereal fodder.

Kerr *et al*. (1986) Indicate that, there have been some efforts to use groundnut hull in cattle feed, and as a fiber component in human diet Hull contains more than 60% fiber, and therefore, has low digestibility.

Sesame straw present low dry matter intake DMI, crud protein intake CPI but high in crud fiber intake. This similar result of Tambal, (2006) who indicates that sesame residues was not initially eaten by the bulls and was rejected. More likely, because of it is bitter taste.

Bougue and Fiems (1988) reported that sesame contains high levels of phytic and oxatic acids in the hulls, making some minerals unavailable and given a bitter taste. This results were agree with Preston and Leng (1987); Mclead and Smith (1989); Van Soest (1994). Palatability is a determinant of feed intake. Palatability is the summation of the taste, olfactory and textural characteristics of the feedstuff that determines its degree of acceptance.

The digestibility

The results of this study showed poor digestibility of the three crop residues under study, sorghum straw (DDM) 33.17 %, (DCP) 47.1 %, (DCF) 27.7 % , groundnut straw DDM 45.97%, DCP 24.27%, DCF 18.23%) and sesame straw (DDM 50.07 %, DCP 19.30 % , DCF (49.90%) Similar results were reported by Donald (2002) less than 50% digestibility failed to meet requirement of animal. The same result sugested by McDonald *et al*. (2002) many factors affecting the digestibility such as feed composition, ration composition, preparation of feed, enzyme supplementation of feed, animal factors and level of feeding.

Coppock *et al*., 1987 indicated that C.P digestibility was 25.6%. However other treatments had negative C.P digestibility due to this deficiency caused by low intake and poor digestibility as concluded by Greenhalgh and Reid (1967). The similar result recorded by McDonald *et al*. (2002) who had reported that mechanical grinding of roughages and pelleting partially destroys the structural organization of the cell wall, thereby accelerating their breakdown in the rumen and increasing feed intake. They studied the relationship between the digestibility of feed and their intake and found a positive relationship between them.

Body weight

The quality of crop residues generally is considered inadequate to provide for much weight gain in young cattle or sheep, unless significant grain remains in the field after harvest. Otherwise, supplement young livestock at all times with protein and energy in order to ensure adequate performance (Shanahan *et al*, 1998).

According to the low levels of dry matter, crud protein digestibility in the crop residues under study and the high level of fiber there were no body weight gain recorded in the experimental sheep lambs . this agree with Donald (2002) who reported, less than 50% digestibility failed to meet requirement of animal.

The lowest DMI values were recorded in the three experimental diets (sorghum , groundnut and sesame straw) content more extensive fiber digestion as a result of increased rumination, similar as shown by Vansoest (1965) it the C.F of forage exceed 44 % of DM it limits the voluntary feed intake.

Conclusion and Recommendations

Conclusion

- It was concluded that according to the study, groundnut straw prood to be the best crop residues in dry matter intake and digestibility to lamb sheep as conservation feed.
- Feeding sesame straw to lamb sheep, affected low dry matter intake, low dry matter digestibility and loss weight.

Recommendations

- Crop residues as they were low in protein content high crude fiber content, treatment and supplementation may increase protein and energy that affected by raising feed intake and digestibility.
- Good conservation, transportation and storage avoid the losses and save the nutritive value against the sun radiation to the crop residues.
- The best utilization of the crop residues in the study area should be grazing not longer after crops harvesting.

Chapter Six

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- عوض عثمان أبو سوار، سبتمبر (٢٠٠٥) ، إنتاج الأعلاف في السودان ، قسم المحاصيل الحقلية كلية الزراعة جامعة الخرطوم .