Feed resources for small ruminants in Libya: A review

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Abstract

The livestock sector in Libya, in particular the small ruminants, plays an important role in the social economy of rural areas. Sheep and goats are primarily raised in traditional systems contributing to the production of meat, milk, wool and skin. Local goats and Barbary sheep use feed efficiently and provide good quality meat. In harsh climatic regions, local plants, bushes or agro-industrial by- products are used as feeds, sometimes mixed with concentrate. However, the main and the major natural resource supporting the livestock production in Libya is the rangeland. In Libya most of the common feed ingredients are imported including a large proportion of forage which are necessary as feed for ruminant animals. Therefore, alternative sources of feeds produced locally have been investigated together with current research efforts to improve the dry matter intake and the average daily gain. The strategies for feeding livestock in Libya are always to concentrate on available feedstuffs, and how they can be used intensively and efficiently. Research and development of technologies have been adapted to improve feed quality for animal feeding for different categories of production systems. Some selected studies are reported in this review. Almost all the research reported in in this literature are studies based on the locally available feed resources

Keywords: feed resources, small ruminants, Libya

Introduction

In Libya the total land area suitable for agriculture is only 1.3% out of the total area of rangelands totaling 166,500 million hectares. Sheep and goats cover about 58% and 14.5%, respectively, of the total red meat consumption of 69,000 tonnes. Per capita consumption of red meat in Libya was 38 kg in 2000. Libya imports about 500,000 tonnes/year of meat, fish and poultry products (ACSAD, 2005). Livestock have made major contribution to human societies by providing food, shelter, fuel, and services. Sheep and goats are economically important livestock species that play an important socioeconomic role for small and large farmers in Libya. Small ruminant animal meat is popular among Libyan consumers, and demand is particularly high during religious and cultural festivals. Small ruminants are valued for their meat, milk and manure, in addition to wool, hair and skins and are becoming more attractive by modern and traditional industries. Goats and sheep play a significant role in the welfare of rural families since they provide both meat and milk as sources of energy and protein for human consumption. Small stock requires relatively lower capital to acquire and to feed compared to large stock.

Sheep and goats play an important role in most small-scale farming systems in many parts of the world. Almost all of small ruminant animals raised in arid and semi-arid zones suffer from shortage in nutrients due to

unstable environmental factors such as low rainfall and high temperatures around the year. Since a long time ago, most of sheep and goat flocks raised in tropical and sub-tropical regions depend upon open system - grazing the native pasture. As a consequence, under this system, sheep and goats are commonly subject to shortage of feed. In Libya, chronic feed deficits result in major constraints to the production of small ruminants, which put extra pressure on farmers to expand the search for feed resources that are not competitive to human needs such as agro-industrial byproducts and crop residues. The above situation can be attributed to the followings: (i) the availability of sufficient and consistent sources of feed for all seasons, (ii) difficulties and added expenses in transporting the feedstuffs and feed crops from production regions to livestock production regions, and (iii) cost of transportation of sheep and goat flocks for grazing from east, west and north to deep in the medial region where rainfall is sufficient to provide good vegetation cover.

Classification of Small Ruminant Production System in Libya

Sheep and goat production systems world-wide are strongly influenced by environmental factors, social policies and economic determinants. Total population of small ruminants is affected by climatic and topographic characteristics, geographical location, purposes and goals of production, availability of feed resources, cost of feeding animals, and the expense for health care and marketing (supply and demand). As a consequence, the production system is found to be strongly affected by the type of production which is influenced by the feeding calendar. Small ruminant animals have been historically and traditionally raised in Libya under traditional methods of production systems, based mostly on grazing. Despite the large number of sheep and goat raised, Libya is a net importer of sheep and goat products.

Open Production System

This is the most valuable and common small ruminant production system in Libya since a long time ago. One recurring cause of nutritional problems in small ruminants is the unexpected change in the amount and ratio of ingredients in the rations in a close production system. Goats and sheep are herbivorous range animals that browse and consume a wide variety of forages, thus as a result, small ruminants have relatively fast metabolism compared to large ruminants, and therefore, they tend to eat more. The digestive systems of small ruminants are sensitive and require time to adapt to changes in the rations. Fortunately, the native pasture grazed by small ruminants in open production system is not widely varied in the quality and does not change from one field to another, therefore, sheep and goats seldom suffer from metabolic diseases in the open grazing production system. The open production system has many advantages compared to the closed system such as (i) sheep and goats seldom face shortages in feeds and water, (ii) genetically, most livestock easily adapted to high temperature and dry weather, (iii) sheep and goats are more efficient in utilizing the native pasture low in quality and water, (v) high resistance to diseases (metabolic diseases) and (iv) flocks move over greater distances between locations. Therefore, parents from these sheep and goat production system need to be selected and used to improve sheep and goat genetic materials may be worth considering.

Intensive Production System

This system is more common in the north and south of Libya where irrigated crop-production is found - it is not different from trans-human system. This production system depends on feeding and grazing on forages and crop residues with supplementation of barley grain and concentrate during winter and autumn to sheep and goat flocks with more concentrate on lambs and kids. Large scale commercials production system, expanded production commercial systems and large-scale commercial enterprises all can be recognized under the Intensive production system.

Mixed Production System

This system is more common in spring and early summer. The grazing area is limited for a certain number of flocks of small ruminant animals. Usually relatives gather together and send their flocks for grazing – giving responsibility to some farmers with animal husbandry experience to look after these flocks during these seasons. These flocks do not normally exceed 20 to 40 heads.

Nomadic Production System

This production system is well known since a long time ago by Libyan sheep and goat herders who inherit the flocks from generation after generation from their parents. This system fits well with the geography of the east region where green mountains are the typical land formations. The sheep and goat flocks normally stray and graze in the local regions when winter is good. The animals graze from morning until afternoon, and come back to the fenced enclosure where they receive bread and barley mix. When the field is not good enough for grazing, the owners apply the same system as in those regions where enough vegetation and crop residues are available, normally between Marage and Daran and supplementation of barley and bread is also practiced. Flocks return back home when winter rain falls and pasture starts to grow in the steppes.

Feed Resources in Libya

Small ruminant production, specifically for the meat market, is one of the fastest growing agricultural production systems. This growth has created opportunities for producers, especially the small scale farmers looking for a profitable alternative enterprise to integrate into their existing production system, and that was due to (i) the availability of feed resources around the year, (ii) the production to cover feed, health, and transportation expenses in spite of the unstable price of feed. Data presented in Table 1 show the main feed resources suitable for small ruminant animals corresponding to each region for the four seasons of the year. This table showed how easy it is to start-up with low capital to create an opportunity for development of a small ruminant production system by a small scale farmer with limited resources. Start-up cost for a sheep and goat production system is considerably low because it requires a small area of land, animals have to perform well on low quality forage diets, and requires less expensive housing structure. Sheep and goats can be used for grazing and feeding the vegetation because of their ability to consume many types of forages and their apparent resistance to many toxins in some plants that are not utilized by grazing cattle. However, the feed resources are used by these small ruminants without the use of any feed additives and alternatives, technological processing of feedstuffs. The ingredients of the most common sources of feed stuffs and low and high land natural pasture are the

most available vegetation for sheep and goats in Libya (Tables 1 and 2).

Table 1. Main feed resources for sheep and goats in different regions and seasons in Libya

Region	Winter	Spring	Summer	Autumn
East	Barley grain, Concentrate, Low and highland natural pasture	Natural pasture, Low and highland natural pasture	Barley grain, Concentrate, Dry native pasture	Concentrate, Barley grain,
North	Barley straw, Concentrate, Alfalfa hay	Natural pasture Barley grain, Concentrate	Crop residues, Dry native pasture	Barley grain, Low and highland natural pasture
West	Barley grain, Concentrate, Alfalfa hay, Green harvested alfalfa,	Natural pasture, Barley grain, Concentrate	Natural pasture, Barley straw, Concentrate	n. a*
South	Oat hay, Barley straw, Alfalfa hay, Crop residues	n, a*	Alfalfa hay, Oat hay, Barley straw, Green harvested alfalfa	n. a*

*n, a – Not available

Table 2. Proximate composition of feed resources in Libya

Feed resource	DM,%	OM,%	CP,%	CF,%	EE,%	Ash,%
Green alfalfa	16.7	97.43	3.72	3.48	0.64	2.57
Oat hay	88.2	92.55	4.29	33.7	1.51	7.45
Wheat straw	85.3	92.6	4.27	33.5	1.5	7.4
Barley straw	-----	92.6	3.2	35.5	1.6	7.4
Alfalfa (bale)	92.6	88.8	19.3	-	4.02	11.2
Oat straw	96.8	93.9	3.89	35.3	0.7	6.1
Sea weed	89.7	92.5	3.2	36.7	0.9	7.5
Dates	93.4	98.5	5.5	10.8	4.4	1.5
Date pulp	93	96.3	6.1	6.7	4.1	3.7
Date kernel	95.5	97.8	3.9	16.4	3.7	2.2
Barley (grain)	91.7	95.3	8.34	4.6	2..51	4.7
Olive oil cake	77	96	7.2	42.5	11	4
Wheat bran	89.4	94.7	17.3	-	4.3	6.3
Olive oil leaves	95.57	93.87	10.04	19.9	2.3	6.13

The values reported in this table were from Animal Production Department Feedstuffs Analysis Laboratory, and Veterinary Centre Feedstuffs Analysis Laboratory.

Table 3 shows that the cost of the feeding materials for sheep and goats is correlated with their quality and not the quantity. When looking for legume hay compared to straw, the prices indicated that legumes were nearly three times more expensive than straw. That also could be due to cost of the facilities, fertilizers, labour and other expenses. Libyan farmers have been feeding cacti for camels more often than sheep and goats, and it is well known in the north.

Table 3. The farm gate price, transportation cost and retail price of common feedstuffs in Libya (in Libyan dollar, LD)*

Feed resource	Price	Weight (kg/unit)	Transportation	Retail price
Alfalfa hay (from south)	4.5	17.5 kg	0.25	6
Barley straw (from north)	2.25	6 - 8 kg	0.25	3
Oat hay (north and south)	4	7 kg	0.25	4.5
Barley straw (from south)	1.75	6 - 8 kg	0.5	3
Oat hay (north and south)	4	7 kg	0.25	4.5
Barley straw (from south)	1.75	6 - 8 kg	0.5	3
Wheat straw	1.5	6 kg	0.25	3
Alfalfa hay (from north)	4	17.5 kg	0.25	5.5
Barley grain	27	50 kg	0.5	30
Concentrate (sheep)	17.5	50 kg	0.5	30
Concentrate (goats)	17.5	50 kg	0.5	30
Olive oil cake	70 - 150	1000 kg	0.25 – 0.50 (by distance)	-
Cactus	Unknown	-	-	-
Dry bread	5	12 -17 kg	0.25 – 0.50 (by distance)	n. a.
LLNP rent/ha*	100 - 200	Ha	n.a.	n.a.
HLNP rent/ha*	100 - 200	Ha	n.a.	n.a.
Green alfalfa	0.5	3 - 5 kg	0.2	1.0

*Prices of ruminant animal's feeds were collected from the most popular livestock markets across the country during 2009.
*LLNP = low land natural pasture, HLNP = high land natural pasture
n.a. not available.

Some problems have developed resulting in low total dry matter production of native pasture per hectare, which could be due to high grazing capacity, as a consequence of illiteracy of pasture management of Libyan farmers; such as rangeland management including grazing periods, duration of grazing time, flock size, flock numbers, native pasture varieties and their quality and distribution of watering points. Farmers are also not aware of several technologies like feed blocks, ensiling, improvement of nitrogen level in poor quality feeds by using urea, alternative feeds, and use of feed additives. Multi-nutrient feed blocks are available at reasonable price and can be used to balance animal ration formulation. These feed blocks can be used to support small ruminant animals especially those receiving poor quality feeds. However,

its use is still not popular enough in Libya compared to some Asian and African countries.

It is possible to increase the nutritive value of dietary intake by making protein more available for digestion through supplementation, and subsequently improve the nutrient utilization, diet digestibility, and growth performance. Small ruminants during the dry season are usually fed forages mainly based on natural rangelands. However, deficiencies of natural pastures in nitrogen, energy and mineral content reduce their utilization by ruminants, and therefore resulting in moderate body gain. As a result, productivity of animals dependent on natural pastures is adversely affected.

Several multi-purpose vegetation can be grown in areas with low rainfall (100 to 200 ml/year), and these can be introduced as grazing field for small ruminants, which might improve the seasonal dry matter production, increase the grazing capacity, improve feed conversion, reduce the conventional feed (concentrates), and therefore, reduce the cost per unit of body weight gain of small ruminants.

Natural grasses, cereal straws, crop residues, and stubbles are the main sources of roughage for small ruminants in Libya. In general, the feeding practice adopted to almost all farms of small ruminants is to graze the annual pasture during spring and autumn, feed on crop residues during winter, and graze the stubbles and dry pasture during summer.

Supplements such as protein, cereal grains and minerals are rarely offered to sheep and goats. Animals are usually unable to maintain their body weight Therefore, grazing alone may not be sufficient for optimizing live weight gain and wool production, and weight losses may and often do occur during the winter season when they are solely fed on straws. The primary limiting factors of cereal straws are their low contents of nitrogen, low intake and poor digestibility (NRC, 2001). Native pastures are mainly grasses which grow naturally and in spite of the differences which exist from place to place, they are generally low in nutritive value.

There is an increasing concern about the protein loss, which affects the average daily gain since the protein value of feed is affected by the amount, form, quality, solubility, and amino acids composition. For optimal performance in ruminants fed on high protein diets, there should be enough readily fermentable soluble proteins to support microbial growth and fermentation in the rumen. Source of less fermentable protein, which can be passed directly to the abomasum (rumen undegradable protein) must be made available. Therefore, an optimal ratio of dietary protein to energy is essential for optimal rates of microbial protein syntheses and rumen fermentation.

That, therefore, will help researchers having clear viabilities about the past and present of this matter since it is established. This study, in addition will help us recognize the factors and facilities on the ground and technical materials and methods needed to establish new technologies. Thus it is important to prioritize the improvement of nutritional status of the small ruminants by integrating different sources of feed, crop residuals, organic by-products and organic industry by-products.

Feeding Calendar for Small Ruminants

Hay falls into several categories: grass, legume, mixed (grass and legume) and cereal grain straw (barley, oat and wheat). These are the more common hays and in some regions of the country Sudan grass is common. The nutritional value of these hays is related to leaf content. The leaves of grasses have more nutrients and are more digestible when immature and growing, and

more fibrous when the plant has reached full growth. Legume leaves, by contrast, do not have the same structural function and do not change much as the plant grows, but the stems become coarse and fibrous. Alfalfa is grown in many geographical regions of the country and has been used as hay for sheep and goats due to its digestibility, palatability and nutrient values, which are high when the plant is young (with more leaves and less stems).

Sheep and goat owners are always keeping grains and cereal stubbles for a season's shortage in native pasture, however, traditionally, barley grain and wheat bran are the most common feed supplements used for feeding sheep and goats when there is shortage of grazing pasture, especially in the drought seasons. Paucity of appropriate vegetation leads to increase in the expenses of keeping livestock and feeding them indoor. Under this circumstance, reduction in farmers' income derived from livestock often occurs, and that is simply due to inefficiency of feed and feeding systems followed by the farmers, although sheep and goats are highly efficient in the utilization of poor quality sources of feeds. Therefore, the feeding calendar of small ruminants is not a fixed attribute in Libya as long as there is flexibility in the rainfall pattern around the year, and therefore, the nutrition situation needs to be re-organized in the form of a regular feeding calendar.

The feeding calendar for small ruminants in Libya are revealed in Tables 4 - 10. These calendars show a monthly listing of common feeding activities for sheep and goats. In these calendars, the periods of time are nearly the same, and not significantly different (Table 2), but diets are different in quality and quantity in some periods, among regions and that is due to the environmental factors, availability, price and transportation. In fact there is no account for the harvesting time, stage of growth and therefore, storage time and quality, however, the feeding calendar for lambs and kids mainly depend on breeding season.

This feeding calendar is not necessarily the best for the entire farmers in one region, and also not essentially followed and applied by all farmers in the same region. Applying this calendar is normally influenced by two factors: (i) accessibility to feed resources and (ii) labour availability. Feeding calendars of small ruminant animals in Libya are not well indicated and organized, therefore, most of sheep and goats' flocks in the north are not necessarily following the four-season calendar (Table 4), although the four seasons are within the same beginning and ending time.

Feeding Calendar for Sheep and Goats in North Libya

This calendar is applied to almost sheep and goat projects across the country as in the following scheme: in February, sheep and goat flocks may receive concentrate or may not, depending on the field condition, if the condition of the grazing field is good, there is no need to support the flocks with concentrate and the same in March, April and May. Sheep and goats normally feed on concentrates and roughages in the morning before allowed to free graze to make sure that the flocks do not come back early in the afternoon to the fences and keep grazing for a shorter period before dark. The mating season for small ruminants starts from June to August, however, rams graze as they rest and thrive on native pasture, crop residues and cereal straw plus concentrate for a month before mating. The above calendar is normally followed by the Government Sheep and Goat Production Projects such as Beer Al-Kanam, Bargoge, Maknosa, Rawann, and Al-Deppowat. This calendar does not support ewes during the flushing season, normally four wk before and four wk during

mating season, since it has been reported by Hidiroglou and Charmley (1990) that better nutrition is in need during this period, for this reason, most of the projects consider grazing cereal stubble as a natural flushing regime for ewes. This calendar can fulfil the small ruminant requirements for maintenance and production around the year and cover the requirements for lambs, ewes and rams.

Table 4. The beginning and ending dates of the four seasons in in North Libya

	Period	
Season	Begin	End
Winter	28 Nov	28 Feb
Spring	28 Feb	28 May
Summer	28 May	28 Aug
Autumn	28 Aug	28 Nov

Table 5. Common feeding calendar for small ruminants projects in Libya

Feed category* / month of the year	J	F	M	A	M	J	J	A	S	O	N	D
BS, AH, OS, RH, or SC + NP												
NP + BS + BG or concentrate (depending on NP)												
NP only												
NP + CS + CR												
NP + OS + AH and or BS												
Concentrate + RH (50% : 50%) pre-grazing												

*BS: barley straw, AH: alfalfa hay, OS: oat straw, RH: Rhodes hay, SC: sheep concentrate, NP: native pasture, BG: barley grain, CR: crop residues, CS: cereal straw.

Feeding Calendar in Southern Libya (Non-Commercial)

There is no open grazing field for sheep and goats in the south feeding calendar (non-commercial). Therefore, most of the flocks are small in size (40 - 70 heads/flock) where owners fed their animals indoor (within the limit of the farm area) with dry and green forage, which is normally harvested by farmers. As a consequence grazing on annual crop residues is essentially practiced through out the seasons (Table 5). Under this feeding calendar, the number of flocks is very large, and the majority of flocks are found in limited irrigated areas. In the southern region, farmers sow legumes such as alfalfa under intensive irrigation system around the year and feed them as green on daily basis and dry when the growth rate is low. Most farmers start feeding green alfalfa and stock up some alfalfa as hay for the cold season when not enough growth for the vegetation although these farmers are under the irrigation system. The feeding calendar in the southern region is strongly influenced by the seasonal patterns of production of alfalfa under infrequent cutting management, thus affecting the small ruminant animal growth and health. No

concentrate and grain supplementation in this feeding calendar, as a result sheep and goats need longer time to reach the slaughter weight, however, the opportunity is available to look at this calendar and introduce new techniques in the feeding materials. Every farmer under this unique circumstance generates his own unique seasonal pattern of forage production. It still pays to describe the seasonal pattern of production that it is interesting and insightful to compare this system, which has not been tried before by the farmers themselves.

Table 6. The beginning and ending dates of two-season periods in southern Libya

Season	Begin	End
Winter	28 Nov	28 May
Summer	28 May	28 Nov

Table 7. Common feeding calendar (non-commercial) for small ruminants in southern Libya

Feed category*/ month of the year	J	F	M	A	M	J	J	A	S	O	N	D
A. Non commercial												
GHA												
AH and/ or OH and BS												
CR (Grazing) + OH + AH (depending on the farmer)												
B. Commercial												
SC+BG + HA and /or BS mix with bread residues												

*GHA: green harvested alfalfa, BS: barley straw, AH: alfalfa hay, OS: oat straw, RH: Rhodes hay, CR: crop residues. BS: barley straw, AH: alfalfa hay, SC: sheep concentrate, BG: barley grain.

Feeding Calendar (Commercial) in Southern Libya

New generation of farmers are always looking for high income within a short period of time. High income projects such as fattening of small ruminants by feeding forages, which are the cheapest feed sources for both sheep and goat production. However, recently, this class of farmers start to introduce the feeding with bread residues mixed with chopped alfalfa or barley straw for fullest extent - for this reason farmers need to store barley straw and/or alfalfa hay for winter feeding. This ration normally reduces feed cost and therefore, increases the farmer income. The farmers traditionally use lambs and kids after weaning since it is the right time for fattening and marketing after a short period of feeding (2 to 3 mo). The problem in these feeding calendars (Table 7) is that the body condition is good but the carcass is high in fat as a result of feeding high on water soluble carbohydrates. Therefore, many technologies have been used to improve feed utilization and animal performance at the farm level, such as feeding treated straw and alfalfa hay. Using urea and nutrient blocks is also beneficial and could reduce carcass fat, which is desired by modern consumers. The southern part of Libya is the region where there is a high number of different varieties of date palms grown. Some poor quality dates due to the high annual production from several varieties are used as feed for ruminant animals with no

treatment. Farmers practicing this activity create new formulae of rations for small ruminants using dates and thereby reduce the expenses of the feeding materials. Under this situation multi-nutrient blocks are particularly successful, for example, using molasses, urea, and olive oil cake, in improving the growth performance of ruminants.

Feeding Calendar of Small Ruminants Raised in Open Fields

This feeding calendar (Table 8) is described as the cheapest feeding calendar in the country, where the rainfall in El-Hamada EL-Hamrra is over 200 mm annually and that due to the no cost grazing field except for the transportation (500 LD/200 heads) one way from north to El-Hamada El-Hamrra. The large grazing fields of El-Hamada El-Hamrra are adequate for a large number of sheep and goat flocks. The large number of grass species gives an opportunity for sheep and goats to select and increase the intake. Sheep and goat flocks are in continuous grazing movement, and that depends on the (i) plant density, (ii) number of animals per flock, and (iii) number of flocks. These factors strongly influence the speed of flock movement in the grazing field. When pasture is in short supply, the majority of flocks are moved back to the closed production systems, giving forages and concentrate, until the next season.

Table 8. Feeding calendar of small ruminants raised in open fields

Feed category*	J	F	M	A	M	J	J	A	S	O	N	D
NP + BG and /or SC)												

*SC: sheep concentrate, NP: native pasture, BG: barley grain.

Feeding Calendar for Rented Grazing Lands

The economic benefit of this feeding calendar is keeping sheep and goat grazing for a long time in a circulating system. Normally, groups of owners (2- 3) rent the same land and combine the flocks for grazing. The owners also grow barley around grazing circles not grazed until the end of grazing of native pasture seasons. The success of this feeding calendar depends on (i) rental of grazing land, which depends on the rainfall, (ii) destination, (iii) total area of the grazing land, and (iv) the landscape of the grazing field. Normally the owners of the grazing land increase rent when the condition is good enough to attractive many of them. No hand feeding of supplements is practised in this feeding calendar (Table 9).

Table 9. Feeding calendar for rented grazing land

Feed category*	J	F	M	A	M	J	J	A	S	O	N	D
NP (if over 200 mm rainfall)												
NP + SB												

*NP: native pasture, SB: sowed barley.

The disadvantages of this feeding calendar are little attention is given to dry ewes and goats until early lactation, ewes and goats in early pregnancy and the nursing lambs and kids. Usually there is no especial management practice for feeding lambs and kids. All livestock must have access to sufficient fresh, clean water on daily basis with water available all the time and not at a long distance from the field. It is common that sudden changes occurred in this feeding calendar such as changes in type of quantity and quality of feeds, especially for those sheep and goats receiving feed from the troughs. Keeping sheep and goats in the same flock did not strongly affect the grazing field since goats usually select grasses over clover, consume only the best part of a wide range of grasses, prefer browse plants including shrubs and trees over grasses, graze the top of pasture canopy before grazing close to the soil level, and that are due to the inability of goats to digest cell wall as a result of short retention in their rumen (Luginbuhl *et al*., 2002).

Improvements of Feed Quality for Small Ruminants

Non-Protein Nitrogen (Urea)

Livestock production in developing countries is largely dependent on fibrous feeds – mainly crop residues and low quality pasture, which are deficient in nitrogen, minerals and vitamins. True protein supplements are expensive ingredients in diets for sheep and goats. Therefore, partial substitution of a true protein supplement with a non-protein nitrogen (NPN) source can significantly reduce feeding cost. Urea is the most commonly used NPN source in ruminant diets due to ready availability and low cost. Urea dissolves quickly in water and is rapidly hydrolyzed to ammonia because of rumen microbial activity. Urea can effectively be utilized when dietary inclusion is limited to one-third of supplemental N or 1% of dietary DM (Reid, 1953; Chalupa, 1968). In contrast, Rennó *et al*. (2005) and Magalhães *et al*. (2006) have demonstrated that intake and performance were not affected when high urea levels (1.95% of dietary DM, approximately 46% of total N as NPN, from urea/ammonium sulphate) were added in the diet or when supplemental true protein was replaced with urea. However, few experiments have been designed to identify the amount of dietary NPN needed for maximum small ruminant performance. Utilization of the correct levels of dietary NPN required for optimum nitrogen use by rumen microbes would allow adequate performance, thereby improving feed efficiency and reducing feed costs and N losses to the environment.

Halfa Hay

Halfa hay (*Stipa tenacissima*) has been grazed and fed as a filler feed for ruminant animals in arid and semi-arid regions, although it is high in crude fiber (46.27%), low in crude protein (5.4%) (Ben salem *et al*., 1994: Gnin, 2005). Salem and Fyez, (2008) treated halfa hay and barley straw using 4% urea and improved the % CP in both which was associated with reduction in CF, EE, and HC, however, the WSC was improved in treated barley compared with treated halfa (Table 10). On the other hand, treated barley lost too much ash compared to non-treated barley which was opposite in halfa.

Table 10. The quality of feeding materials (from Salem and Fyez, 2008).

Item	DM%	CP%	CF%	EE%	HC	ADF	NDF	Ash	NFE
Untreated barley straw	91	4.00	46.17	1.25	26.41	71.0	44.6	8.3	40.31
Treated barley straw	82	7.91	40.62	1.00	24.09	72.2	48.1	4.7	45.81
Untreated halfa	92	5.40	46.27	1.32	29.97	80.4	50.4	2.5	44.51
Treated halfa	86	6.27	45.20	1.00	29.47	82.2	52.7	3.7	43.86

The digestion coefficient of treated barley was much improved compared to non-treated; however, treated halfa was not improved in all ingredients, and therefore the DMI was also not improved compared to both treated and non-treated barley straw. The results as reported in Table 11 show that the digestion coefficient of DMI, CP, CF and TDN was at maximum in group offered non-treated halfa compared to the rest. Although DMI of treated and non-treated halfa were not significantly different, water consumption, faecel excretion, and urea excretion were the lowest in the group fed non-treated halfa (Figure 1). The conclusion of this study is that utilization of halfa when mixed with legume hay may reduce the cost of DMI and therefore, sheep production especially meat production.

Table 11. The digestion coefficients of DMI, CP, CF and TDN of treated and untreated barley straw and halfa straw (from Salem and Fyez, 2008)

Item	Digestibility coefficients (%)			
	DMD	CPD	CFD	TDN
Non-treated barley straw	54.22	50.12	45.97	47
Treated barley straw	68.59	69.19	73.24	69
Non-treated halfa	76.68	78.69	79.71	77
Treated halfa	65.29	69.15	59.58	65

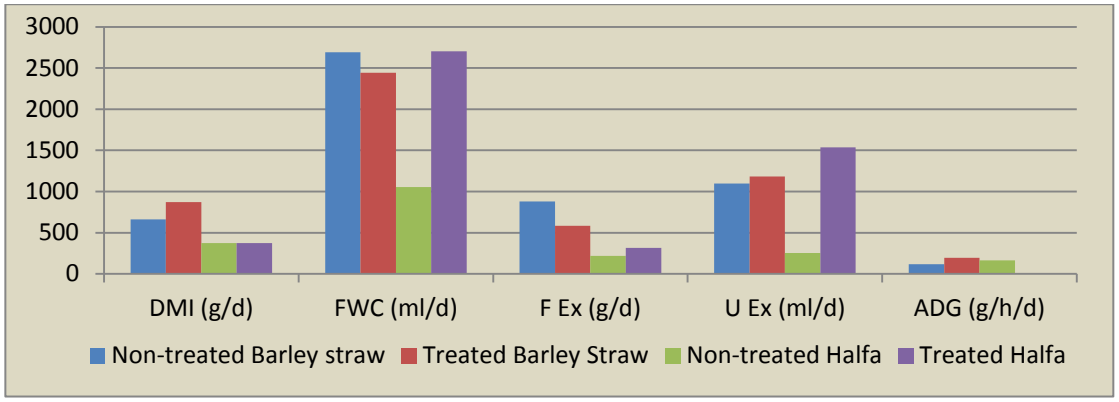


Figure 1. Animal performance (from Salem and Fyez, 2008).
FWC; free water consumption, F Ex; Fecal excretion, U Ex; Urea excretion.

Olive Oil Cake

The finding obtained and reported by Abubaker and Makke (1986) showed that feeding of 15% of olive oil cake to male and female Barbary sheep aged 4 to 5 mo, when the olive oil cake was mixed with oat hay, sheep concentrate and treated by urea resulted in the average daily gain of 141.9 g/h/d for male, and 117.5g/h/d for female in ration with 15% olive oil cake compared to 25 and 50% of olive oil cake. Feeding olive oil cake treated with urea could substitute considerable amount of concentrate and reduces the cost of the body weight gain in sheep, especially young sheep. The carcass of animals fed olive oil cake had more subcutaneous peritoneal fat, fat under the skin, around the kidney and the heart, and that it could be a result of the high percentage of oleic acid (65 to 68%), and linoleic acid (5 to 15%).

Olive Oil Cake Silage (OOCS)

Tayer and Rafege (2008) fed 18 male Barbary sheep aged between 7 and 8 mo, with average body weight of 39.75 kg on olive oil cake silage at three different levels: 0, 20, and 30% for 6 wk. The results reported in Table 12 showed the average DMI was 208.02, 407.02 and 524.04 g/h/day for 0, 20 and 30% of olive oil cake silage, respectively. The changes occurred in the animal body weight did not show any significant changes on the final weight, 46.92, 47.58, and 46.88 kg/head in groups fed diets containing 0, 20, and 30% of olive oil cake silage, respectively. However, the palatability was found to be higher in the group offered ration containing 30% olive oil cake silage compared to the rest.

Table 12. Lamb performance fed 0, 20 and 30% of olive oil cake silages (From Tayer and Rafege, 2008)

Parameter	Control	20% OOCS	30% OOCS
OOCS intake (g/h/d)	208.02	407.02	524.04
DMI (g/h/d)	1507.12	1793.28	1830.14
ADG (g/h/d)	166.67	184.52	175.51
OOCS intake (g/h/d)	208.02	407.02	524.04
Dig. coef (%) of DM	65.5	62.75	61.6
Dig. coef (%) of CP	74.63	75.45	76.75
Dig. coef (%) of EE	69.73	72.76	86.37
Dig. coef (%) of CF	40.95	34.32	23.35
Dig. coef (%) of NFE	75.06	73.98	69.52
TDN (%)	59.12	55.02	50.57

The maximum percent of TDN was in group fed no olive oil cake silage, and this could be a result of the maximum digestion coefficient in the nitrogen free extract. Feeding olive oil cake silage to Barbary sheep is found to improve the palatability by increasing the DMI (g/h/d), however, the ADG (g/h/d) was the best in lambs in the group fed 20% olive oil cake silage, moreover, the digestion coefficient was the highest in the group fed 30% olive oil cake silage.

It is concluded that feeding olive oil cake silage is possible at 20% since it gives good final weight compared to the rest. Therefore, feeding olive oil cake silage to Barbary lambs improves the ADG resulting in improved palatability because of addition of olive oil cake silage.

Dissolved Olive Oil Seed Cake (DOOC)

Dissolved olive oil seed cake (DOOC) is obtained after oil extraction of OOC using a solvent, usually hexane, which further dissolves the residual oil in the olive oil cake. This OOC is low in oil and generally is lower in energy content compared to OOC. Tayer *et al.* (1967) fed diets containing 0, 15, 30 and 45% DOOC in corn-barley diets to Barbary sheep aged 7-8 mo and showed that the group fed diet without DOOC cake had the maximum TDN (85.52%), while the TDN for 15, 30 and 45% were 81.3, 73.3, and 68.73% respectively, although DOOC was higher in CP and lower in CF, and EE compared to the OOC (Table 13).

Table 13. Proximate analysis of olive oil cake (OOC) and dissolved olive oil cake (DOOC)*

Nutrient	CP, %	EE, %	CF, %	Ash, %	NFE, %
OOC	9.8	16.0	22.3	2.1	49.8
DOOC	12.8	6.0	17.9	6.8	50.9

*From Tayer and Rafege (2008).

The correlation between TDN and DOOC intake on DMB was found to be negative (Figure 2) which means that as the DOOC intake increases, the TDN decreases dramatically, suggesting that feeding DOOC to Barbary sheep affects negatively the TDN values. Thus the best rate of DOOC was 15% in both TDN and DMI since the DMI was minimum. In group 2 reduction of 11% and 2% in barley and corn on DMB, respectively, compared to the control, made this treatment more attractive to be used.

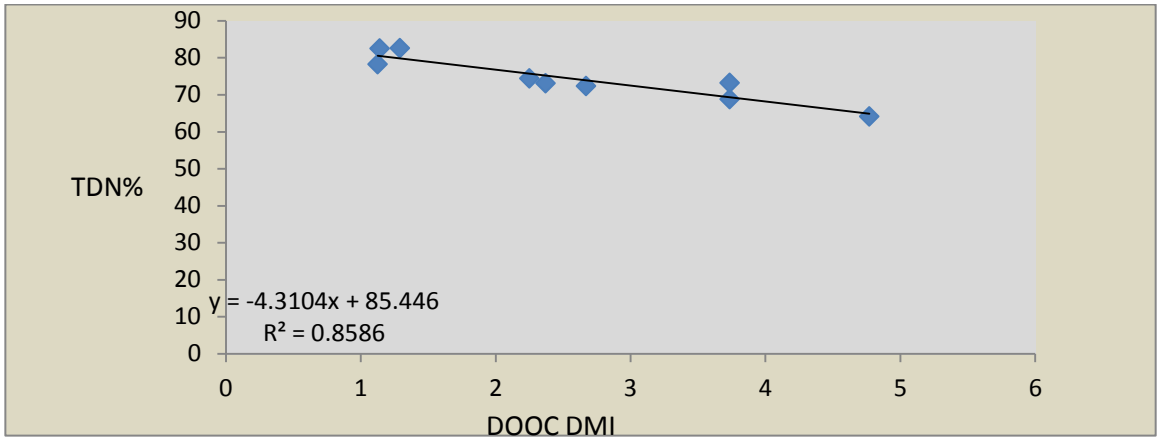


Figure 2. The correlation between TDN and dry matter intake (DMI) of DOOC in Barbary sheep fed diets containing increasing amounts of DOOC.

Olive Leaves

Olive tree leaves have been grazed and fed to the small ruminants since a long time ago. Effects of olive leaf supplementation on growth, digestibility, and feed conversion efficiency until recently have not been reported extensively. Salem and Nezar (2008) stated that treated barley straw was positive in improving crude protein intake, and olive leaves were considered as good roughage sources for sheep as the total dry matter intake was higher than those fed untreated barley straw (Table 14).

Table 14. Dry matter, organic matter and protein intakes, average daily gain and feed conversion ratio in sheep fed diets containing olive leaves (From Salem and Nezar, 2008)

Diet*	DMI (g/h/d)	OMI (g/h/d)	CPI (g/h/d)	ADG (g/h/d)	FC (kg feed/kg gain)
BS	521.03	482.48	16.67	65.08	12.53
UBS	620.02	567.32	44.64	113.81	8.89
OL	839.59	769.32	53.31	149.13	8.93

*BS barley straw, UBS untreated barley straw, OL olive leaves

The best DMD, OMD, CFD, and CPD was found to be in group fed on treated olive leaves (TOL) by 4% urea. However, this improvement in lamb performance reported in group offered TOL could be due to the treatment by urea and a result the optimum pH which improved the rumen microorganisms activities in digestion of DM, OM, CF and CP (Table 15).

Table 15. Digestibility of organic matter (OMD), dry matter (DMD), crude fibre (CFD) and crude protein (CFD) (From Salem and Nezar (2008)

Item	pH	OMD	DMD	CFD	CPD
BS	7.15	48.59	42.56	42.70	41.88
UBS	6.70	58.11	56.42	62.10	65.45
OL	7.30	61.69	59.28	58.92	64.32
TOL	7.06	65.25	63.02	71.26	74.45

The value of the olive leaves from the chemical analysis (Table 16), digestibility, and sheep performance, was studied by Abubaker and El-Dahman, (2007) who offered olive leaves as a roughage source to twelve Barbary sheep with an average of body weight of 55.29 kg/head for 21 d (14 d adaptation period and 7 d, sampling period, respectively). The experiment consisted of three treatment groups of 4 animals, with OL replacing 50% and 75% of barley straw as roughage, namely 100BS (100% barley straw) , 50OL50BS (50% OL and 50% BS), and 75OL25BS (75% OL and 25% BS). All animals were given 1 kg of sheep concentrate per group each.

Table 16. Nutrient composition of dietary treatments (From Abubaker and El-Dahmane, 2007)

Treatment*	DMI (g/h/d)	DM, %	OM, %	CP, %	EE, %	CF, %	Ash	NFE
100% BS	1611.5	92.76	94.05	16.8	1.5	4.7	5.20	71.8
50% OL: 50% BS	1854.5	95.57	93.86	10.0	2.3	19.9	7.95	59.8
75% OL: 25% BS	1912.6	97.43	88.50	4.9	0.6	35.2	10.23	49.1

*BS barley straw, OL olive leaves

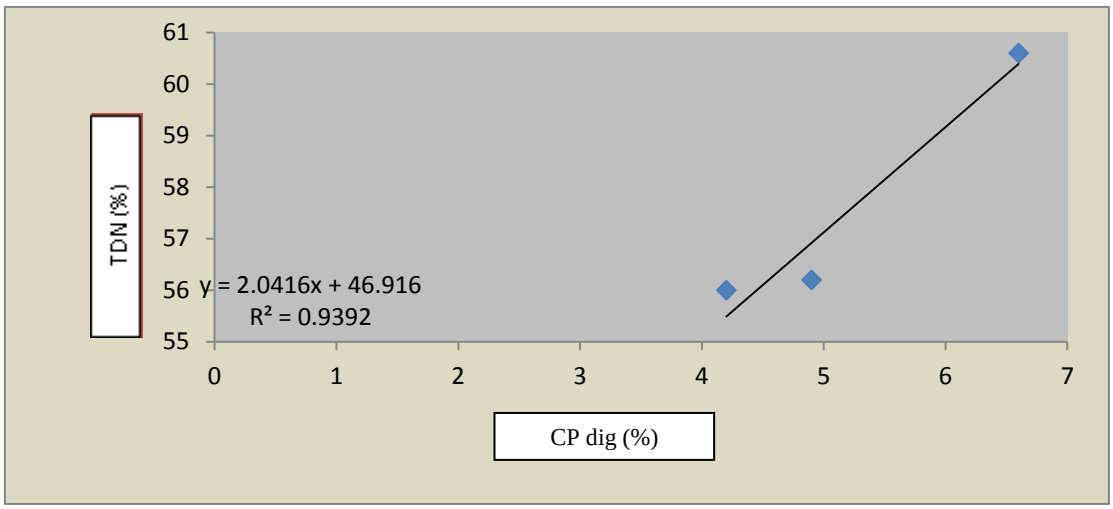
Table 17. The digestibility coefficients of crude protein, crude fiber, dry matter, ether extract, nitrogen free extract, NDF, ADF and TDN (From Abubaker and El-Dahmane, 2007)

Digestibility coefficient	100% BS*	50%OL: 50% BS*	75% OL: 25% BS*
Crude protein	60.2	45.9	39.7
Crude fiber	47.3	37.5	35.4
Dry matter	63.9	59.2	58.1
Ether extract	55.5	49.8	57.9
Nitrogen free extract	71.5	70.1	71.2
NDF*	50.1	42.1	47.6
ADF*	34.4	24.4	16.7
TDN*	60.6	56.2	56.0

*BS; barley straw, OL; olive leaves, NDF; neutral detergent fiber, ADF; acid detergent fiber, TDN; total digestible nutrients.

The correlation between the degradable crude protein (DCP) and TDN was found to be positive and the high TDN and ADG (g/h/d) could be due to this not to the DMI (g/h/d) since the minimum DMI was found in group 1 as shown in Figure 3.

Figure 3. The correlation between CP digestibility and TDN (From Abubaker and El-Dahmane, 2007)



Bushwereb and Rabeie (1978) studied the digestibility of three different rations; A: barley straw, straw molasses and urea at 30% of the protein requirement /head/day, B: barley straw and molasses, and C; concentrate, barley straw and molasses. The crude protein in each ration was adjusted to 11%. These three different rations were fed to three groups of three Barbary lambs each at an average body weight of 37.3 kg/head for 51 d. No significant difference was reported in the digestibility of protein, fat, dry matter, total digestible nutrients, digestible energy, and body weight gain (g/head/d). However, ration B was significantly different in crude fiber

digestibility compared to rations A and C, and concluded that urea could be used at 30% of the total protein required by small ruminant animals. The protein intake (PI), TDN and ADG and digestibility of nutrients are reported in Tables 18 and 19.

Table 18. Effects of feeding urea on lamb performance (From Bushwereb and Rabeie, 1978)

Group	TDN, %	ADG (g/h/d)	PI (g/h/d)
A	49.2	83.28	24.11
B	63.9	107.14	26.557
C	49	107.14	32.24

Table 19. Lamb performance (From Bushwereb and Rabeie, 1978)

Group	DC* of DM	DC* of CP	DC* of EE	DC* of CF	DC* of NFE
A	54.1	41.8	12.8	67.3	93.6
B	62.1	41.0	34.9	77.3	91.4
C	55.6	39.7	44.9	66.0	95.3

*DC digestibility coefficient

Feed Blocks

The activities in Libya in making feed blocks started in 1997 in association with Mashreq and Maghreb project reported by Nefzaoui *et al*. (1997), and that after participation of technicians in a training course on alternative feed sources held in Tunisia in 1996. It has been reported that, there were three tries in making feed blocks in Libya by using urea, molasses, ground barley, wheat bran, olive oil cake, salt and limestone in three different proportions of these components. Support of the small ruminant animals such as sheep using feed blocks might give good indicator on sheep performance, and could be applied on small and large scales. Abubaker and Ali (2008) studied the effects of three different feed blocks in their chemical composition (DM%, OM%, CP%, CF%, and NFE) (Tables 20 and 21) on sheep performance compared to the control group grazed on barley residues, and that by using 40 male Barbary lambs 6 to 8 mo of age, with an average of body weight 45 kg/head. The experiment was carried out for 10 wk.

Table 20. Feed block composition (From Abubaker and Ali, 2008)

Feed	OM, %	DM, %	CP, %	CF, %	NFE, %
Feed block 1	86.9	66.4	13.7	20.5	40.2
Feed block 2	82.2	47.2	12.1	10.0	39.9
Feed block 3	83.6	49.9	12.8	12.3	35.1
Barley residue	84.5	94.0	5.7	30.7	49.4
Barley straw	88.5	94.0	4.9	42,0	44.1

Table 21. Initial weight and final weight of Barbary lambs fed feed blocks (From Abubaker and Ali, 2008)

Group*	Initial weight (kg)	Final weight (kg)	Total gain (kg/h)	ADG (g/head/day)
Barley straw	41.02	55.87	14.85	0.212
FB1+ BR	40.92	53.17	12.25	0.175
FB2 + BR	41.98	54.95	12.97	0.185
FB3 + BR	41.44	60.67	19.23	0.275

*FB feed block, BR barley straw

The result proved that lambs fed on FB 3 and barley straw gained more than lambs in groups 1, 2, and 4. This could be due to the average of dry matter intake (670 g/head/day) compared to 473, 427, and 611 g/head/day, in control, FB1 and FB2, respectively.

Seaweed as Feed for Ruminants

Seaweed is a potential feed for ruminants as it is available in large quantities throughout the year in some regions of Libya. Although when processed it is costly, it can be used as a filling feed for small ruminants. In a six-week feeding trial, Tayer and Addal, (2007) fed 16 male (3 to 4 mo of age) local goats on seaweeds as a source of roughage in order to examine the DMI, ADG, and feed conversion ratio, of goats fed barley straw, and barley straw mixed with seaweed. The diet offered is as shown in Table 22.

Table 22. Composition of diets based on seaweed offered to local goats (From Tayer and Addal, 2007)

Group	No. of animals	Concentrate, %	FF type and (%)*	% of FF
A	4	60%	100% BS	40%
B	4	60%	50% BS: 50% SW	40%
C	4	60%	25% BS: 75% SW	40%
D	4	60%	100% SW	40%

*FF forages fed, BS barley straw, SW sea weed.

Table 23. Average daily gain of local goats through out the 45-day trial (From Tayer and Addal, 2007)

Group	IW* (kg/head)	FW* (kg/head)	ADG* (g/head/day)	ADMI* (g/head/day)	FC* (g feed/g gain)
A	11.960	14.475	59	360	6.440
B	12.187	14.025	41	358	8.754
C	12.262	14.775	56	350	6.271
D	12.387	14.900	56	334	5.980

*IW; Initial weight, FW; Final weight, ADG; average daily gain, ADMI; average dry matter intake, FC; feed conversion.

The above results reported the importance of seaweed as a filling feed, when offered with 50% mixed with barley straw. The results reported in this study are economically important since the seaweed is easy to find and available all around the year, cheap, and acceptable by the ruminant animals. Treating seaweed with urea and molasses could improve the appetite and palatability in rations of small ruminants; Abubaker *et al*. (1993) using two groups of 8 local goats aged from 9 to 12 mo, in order to study the local goats' performance; when washed seaweed treated with 5% urea and non-washed seaweed mixed with 5% molasses to define more precisely the importance of seaweed straw from the quality point of view. The result showed an improvement in treated seaweed straw dry matter intake compared to that obtained by Abubaker *et al*. (1992).

Abubaker *et al*. (1992) studied the effects of feeding of non-washed and washed seaweed on dry matter intake using three groups of 6 kids each. Kids were 5 and 8 mo of age, with an average body weight of 16.5 kg/head. The control group was offered barley straw and sheep concentrate, non-washed seaweed and sheep concentrate was offered for treatment 1 and washed seaweed and sheep concentrate was offered to treatment 2 for 54 d. Feeding seaweed washed or non-washed appeared to have no influence on the average daily gain in local goat kids.

Conclusion

In Libya a high proportion of livestock owners are dependent on native pasture for their livestock feeding, therefore, researchers should concentrate on improving the management of native pastures to maintain their quality. Native pasture species are diversified in agronomic characteristics and nutritional values and need to be understood before improvement strategies can be implemented. Cactus has become more important due to the low water requirement, resilience and hardiness and is known to be palatable and intake by livestock especially in arid and_semi-arid zones. The product of this plant becomes more effective on animal production as a result of proposal of this plant as animal feed, human food and agricultural adaptation. The Libyan land is suitable for this plant and it can give high yield easily, therefore, research need to be focused on cactus as a novel pasture species.

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