SHEEP MANAGEMENT ON MOROCCAN RANGELANDS

by

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ABSTRACT

This paper deals with the ecology and management of sheep on arid range lands, with emphasis on the Moroccan situation. General nutritional requirements, grazing behavior, diet selection and plant-animal relationships are discussed. The particular situation in Morocco is presented, including the importance of sheep and their traditional modes of management. Social and political reasons for range deterioration are presented, and recommendations for improvement are made.

CHAPTER 1

INTRODUCTION

A great part of the earth's surface is classified as arid lands, mostly inhabited by pastoral people and their animals. Due to the climate and physical environment of the arid lands, grazing by domestic livestock is their major economic use. These areas have considerable potential to offer adequate livestock nutrition, but in some countries (undeveloped) they have not been intensively and properly exploited for suitable animal production to meet the needs of a growing population.

On such areas, sheep is one of the domestic species that has existed for thousands of years. For instance, in Moroccan arid regions sheep were and still are the most important domestic animal raised by the majority of the rural population for many purposes. However, the production has been always relatively low when compared to that in other countries. The causes of this low productivity are numerous, but the main factor seems to be nutrition, since it affects directly the yield of animal products. On Moroccan arid lands sheep depend all year on forage provided by seasonal rangelands which have been grazed and exploited improperly for many years.

The purpose of this paper is to review the nutritional patterns such as grazing behavior, diet quality and selection of sheep in the arid rangeland and to present the potentials and problems facing sheep nutrition on Moroccan arid rangelands. Finally, the paper will develop some recommendations for increased sheep productivity through range and sheep management.

CHAPTER 2

SHEEP IN THE ARID RANGELAND ECO-SYSTEM

Characteristics of the Arid Lands

The exact extent of the world's arid lands will vary depending upon the definition of the aridity. Two criteria have been widely used in defining the arid lands: the climatological indices and the biological criteria. Meigs (1953) calculated that approximately one-third of the earth's surface is arid or semi-arid when the climatological indices are used. On the other hand, Perry (1967) reported that more than one-third of the earth can be considered arid when the biological criteria are applied.

The climate of the arid regions is subject to extremes of temperature and humidity. It is characterized by low and undependable precipitation. Rainfall is poorly distributed spatially, seasonally, and yearly. Mean annual rainfall over a period of years may not be correlated between two stations 60 km apart (Wagner, 1976). Long periods of drought and sparsity of perennial streams are very common in arid regions.

Arid lands are most generally known for their low biological productivity. The production of vegetation is low and highly variable due to the variation of the rigorous

climatic conditions. Production may vary by factors of 5 to 10 between high and low rainfall years (Wagner, 1976). The deterioration of the plant community and loss in the composition of the more stable plants on arid rangelands has been noted as a result of heavy continuous grazing by domestic animals (Stegner, 1962).

The climatic restriction imposes severe biological constraints which directly affect man's economy. Agriculture often requires irrigation to supplement natural precipitation and extend the productive season. However, in many arid lands of the world, water is not suitable for irrigation because of its high salinity and other undesirable element content. In the arid zones the primary industry is limited almost exclusively to the grazing of domestic animals on natural pastures for red meat and animal fiber production.

Most arid regions of the world have low human population density. For instance, the Australian arid lands are inhabited by only 3 percent of the national population whereas 86 percent of Australians reside in the coastal-urban region, 3 percent of the continent's land area (Everett and Vickery, 1978).

Most arid lands around the world have underdeveloped characteristics: nomadic pastoralism, difficult communication, and poor transportation. There are some

exceptions, including the western portion of the United States and semi-arid areas of South Africa and Australia.

Characteristics of Sheep in the Arid Rangeland

The rangelands in the arid regions are a heterogeneous complex varying from shifting sandy plains to rocky areas to saline flats. The major use of the arid rangeland ecosystem is usually grazing because of the hostile agroclimatic conditions, but many other goods and services are offered. Sheep is one of the domestic animals that play on important role in the economy of many arid regions of the world. However, they do require more labor than some other species, both in day-to-day management and for shearing.

Problem of adaptation. Sheep in the arid regions are reared more with the objective of land utilization than in preference to other livestock. Here, the vegetation types are more suited biologically to sheep than to cattle and other domestic species. Squires (1981) indicated that sheep are more successful than cattle under the conditions of nitrogen deficiency and poor water quantity and quality which are typical of arid rangelands.

In view of the extremes of temperature and humidity, climatic stress might be expected to be a major constraint to sheep adaptability. However, the indigenous breeds in their natural environment have little difficulty in coping with these stresses, unlike exotic breeds when introduced to

a given arid environment. A study in the northwestern Indian desert showed that one of the first noticeable responses of animals to thermal stress is a reduction in feed intake (Singh, 1980). Observations made on the grazing habits of sheep in arid areas reveal that the direct stress of hot climates cause serious curtailment of grazing by European breeds of sheep, while their indigenous counterparts are less affected. During the hotter parts of the year (above 38°C) under semi-arid conditions, a marked deterioration in semen quality was observed in Rambouillet sheep, while the semen quality was reportedly better in Rambouillet crosses with Malpura or Chokla (Tiwari and Sahui, 1975). In ewes, high ambient temperature shortens the duration of visible expression of estrus and decreases embryo survival (McDowell, 1972).

Under hot and dry conditions, heat and water loss can lead to death of some exotic breeds not well-adapted to the environment. Indigenous breeds dissipate body heat in a manner that allows them to tolerate hot conditions. Singh (1980) found that under thermal stress (33.5°C under the sun) the Rambouillet pant while the Malpura do not, indicating that Indian Malpura sheep utilize cutaneous evaporative cooling for dissipating body heat rather than the respiratory evaporative cooling of the Rambouillet.

Nutritional requirements. In general, sheep, like other ruminants, need energy, digestible proteins, phosphorus,

vitamins, and water for maintenance, body weight gain, growth of fetus, milk production and wool production. It is known that grazing sheep require more energy than sheep in a confined system, because animals travel greater distances in the process of obtaining food on the range. It is difficult to identify or compartmentalize the energy utilization for each physiological function (Cook, 1970), since the physiological functions take place simultaneously.

The nutritional requirements of sheep vary with the age of the animal, its physiological status and its state of production, and with topographic features of the terrain and the gait at which the animal travels. The latter is influenced by weather conditions, availability of forage, location of watering facilities, and placement of salt over the range (Cook, 1970). Clapperton (1964) calculated the apparent energy cost of horizontal locomotion of sheep walking 1.5 Km to be from 39 to 41 kilocalories per 100 pounds of live weight.

The water requirement of sheep depends on the nature of forage and weather conditions. If the forage is green and succulent, the amount of water needed will be much less than if the feed is dry. On salt-desert winter ranges in Utah, Hutchings (1946) pointed out that on especially dry feed, consumption was 5.7 liters per day; on very salty feed, consumption was 6.8 to 8.3 liters; and in warmer spring months, consumption averaged 3.3 compared with 2.4 liters in

colder winter months. In some instances (e.g., where saltbush (Atriplex spp.), and other highly saline forages are prominent) the water requirement will be higher (Wilson, 1966) and drinking frequency greater. More water is required by sheep when the temperature is high and the humidity is low, because both these factors cause losses from the body (Stoddart et al., 1975).

Grazing Behavior

Ensminger (1977) defined animal behavior as the reaction of the whole organism to certain stimuli, or the manner in which it reacts to its environment. It is important that the rancher or pastoralist be familiar with the behavioral norms in order to detect abnormal situations and obtain maximum production and efficiency. Behavioral activities of sheep affect rangeland vegetation through trampling and selective grazing (Squires, 1976). Studies of sheep behavior and performance under rangeland conditions have potential value in solving managerial problems in the pastoral zones (Lynch and Alexander, 1973).

Sheep under arid circumstances have the ability to adapt physiologically and behaviorally to these environmental conditions. They can adjust their behavior to tolerate changes in the temperature and other climatic factors that are most common in arid rangeland eco-systems. Sheep behavior appears to be influenced by forage availability, time of the year, and water point distribution. Besides

these factors, the expression of individual variation is modified by the total activity of the whole group, since sheep are characterized by performing social activities. The behavioral patterns of sheep can be modified by man's interference in term of distance between watering points, location of fences, and provision of salt and supplements, as well as herding and confinement.

Because arid rangelands are often characterized by the sparsity of forage and long distances between food and water, grazing, walking and drinking are the activities that have received most attention in research. Many factors affect grazing time, including the availability of forage and the season of the year. Research shows that differences in grazing time are related to the temperature of the day. Squires (1976) reported that the average duration of grazing, resting, and walking was similar when he compared the behavior of two similar groups of Merino ewes grazing either a saltbush or a grassland area in the Australian semi-arid rangelands (Table 1). Figure 1 shows the activity patterns of the sheep on each site for four separate 24 hour periods in December, January, February, and March, respectively.

Walking is one of the activities that consumes the most time and energy of sheep on rangelands. Forty percent of daylight hours for sheep are spent in walking, and greater times have been observed under extreme drought conditions

TABLE 1. Average Duration (Hours) of Activities of Merino Ewes on Two Different Sites (Squires, 1976).

Activity	December		January		February		March	
	Salt-bush	Grass-land	Salt-bush	Grass-land	Salt-bush	Grass-land	Salt-bush	Grass-land
Grazing	4.2±.08	5.1±0.7	6.7±0.9	7.2±0.7	6.5±0.6	6.9±0.7	7.3±0.8	7.6±0.5
Resting	8.2±0.7	6.5±0.4	7.4±0.6	7.0±0.3	6.5±0.4	5.5±0.4	5.5±0.5	4.5±0.6
Walking	3.0±0.2	4.0±0.4	4.2±0.4	4.2±0.5	4.8±0.6	6.2±0.7	5.2±0.7	6.7±0.6

(Squires, 1981). However, differences in walking distances have been reported by many authors, depending upon the breed, the physiological status, age, and degree of dehydration. In his study on saltbush and grassland areas, Squires (1976) found that the average daily distance walked was lower for sheep on grassland than on saltbush range (Table 1).

Also, Squires (1976) found that on both sites the sheep drank once daily except in March, when the group on saltbush drank twice daily, but water intake was more than twice as great for sheep on saltbush range (Table 2). Wilson (1974) assumes that sheep drinking twice daily would be less likely to expend time and energy foraging at distances remote from water.

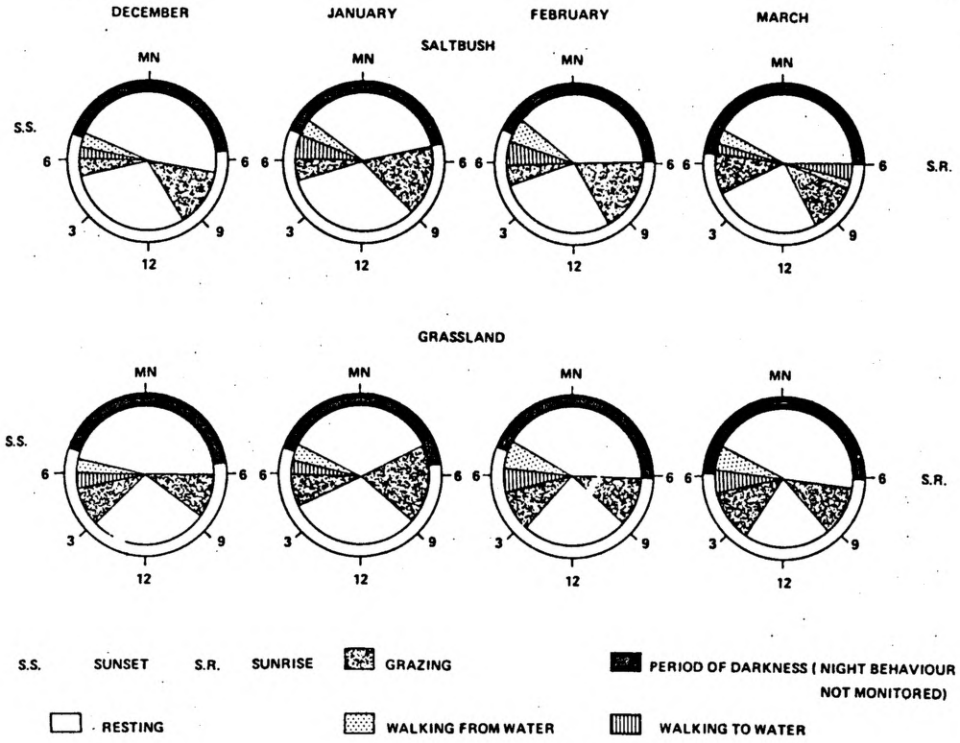
TABLE 2. Daily Water Intake by Merino Ewes on Two Different Range Sites (Squires, 1976).

Month	Water Intake (l/sheep/day)		Difference
	Saltbush	Grassland	
December	2.31	0.63	1.67
January	4.72	2.45	3.59
February	4.32	2.18	2.64
May	9.30	3.10	5.54

There are diurnal patterns for many activities of free-ranging sheep. However, in some areas of the world such as Morocco diurnal patterns don't exist because sheep flocks are always kept by a herder during the day and are confined without food and water during the night. This action of man may allow sheep to perform certain grazing behavior different from that of free ranging sheep in the western

United States and Australia. No studies have been done on sheep behavior under the arid conditions of Morocco.

FIGURE 1. Distribution and Duration of Grazing, Resting, and Walking During 24 Hour Periods in December, January, February, and March on Two Contrasting Rangelands (Squires, 1976).



Diet quality and selection of sheep.

The development of new techniques in range animal nutrition provides a good understanding of factors that can influence what the animals get from the environment. Grazing animals must select from the plant community adequate nutrients to meet their requirements, which vary according to the physiological state of the animal. In many cases,

animals are not able to meet their needs from preferred forage. This indicates that changes in selection and nutritive value of the diet can occur.

Selection. Selection is defined as a subjective value on availability of forage types and quantity. Sheep are more selective than cattle. Therefore, their diet is higher in soluble carbohydrates and protein and lower in crude fiber (cellulose and hemicellulose) and lignin. In some studies, it was found that sheep select on a soluble sugar basis (Heady and Torell, 1959). Sugars added to a forage with low palatability showed relatively higher selection. Other studies showed that of all chemical ingredients protein content is best correlated with selection by sheep (Heady and Torell, 1959). The nutritive value of a plant is often the best indicator of its palatability. Many authors have shown that sheep select a diet higher in nutritive value than the vegetation average. Even on poor quality range they select high quality forage by spending more time grazing and selecting the most nutritious part of the plants.

The amount of chemical compounds varies greatly among plant parts. Because of the high content of ether extract and crude protein and the low content of lignin and crude fiber, sheep prefer leaves to stems. These compounds vary with the growth stage of plant. Heady and Torell (1959) reported that as grasses mature, they decrease in crude

protein and increase in crude fiber, lignin, cellulose and other carbohydrates. This change in chemical composition over the age of plant species, may be affected by the leaf/stem ratio, which decreased with the maturity of the plant.

Generally, grazing sheep select high quality forage and select leaves over stems and green material over dry material. However, selectivity is not always manifested and sheep meet their needs from previously rejected plant species. McClymont (1965) pointed out that when hungry ruminants are introduced to an unfamiliar area, they may consume toxic plants if toxic plants constitute a major part of the plant community. A grazing animal manifests preference when surrounded by many plant species which differ greatly in their chemical and physical characteristics.

Selectivity for a given forage species depends upon the availability of other species. It is also influenced by the seasons of the year, which are related to the climatic conditions. Under certain weather conditions sheep may be forced to consume a less palatable forage species. This point was illustrated by Severson and May (1967) in their study of sheep in the big sagebrush (Artemisia tridentata)-grass type winter range in Wyoming. They indicated that due to their growth time the grass species consumed by sheep vary over the season of the year. Figure 2 shows that

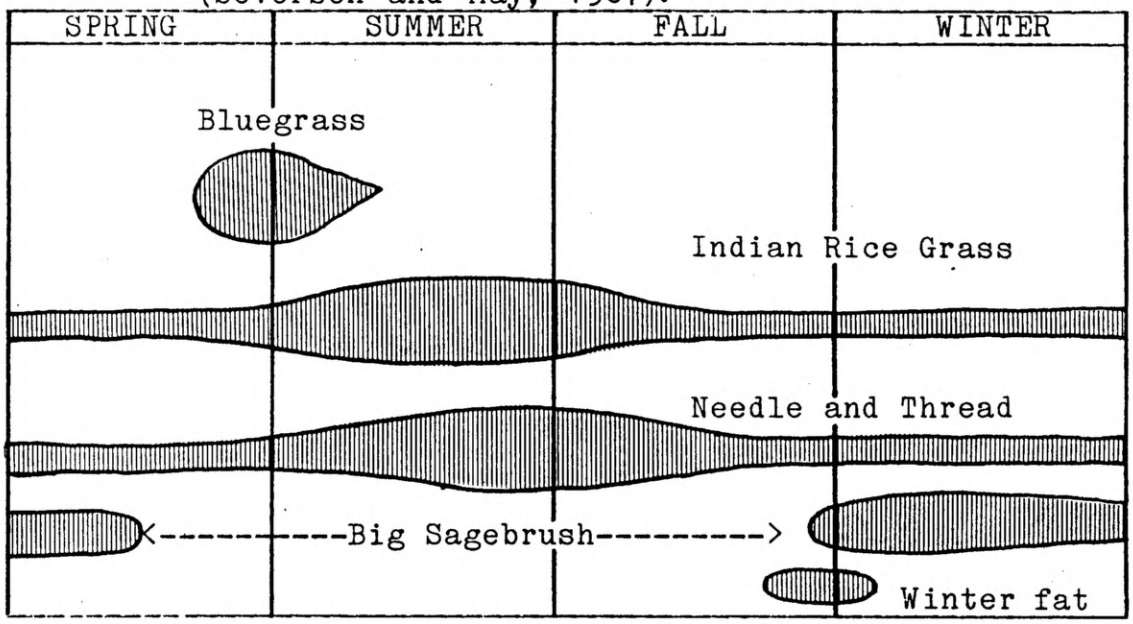
bluegrass (Poa spp.) was used in early spring because it was the first species in the plant community to initiate spring growth. As other plant species grew, bluegrass became less conspicuous in both plant composition and animal diets. Big sagebrush, a less palatable species, was used by sheep during winter. This increased use of sagebrush was due partially to the snow depth that decreased grass availability during the winter season.

Diet Quality. It is believed the the nutrient content of sheep diet in the arid rangelands depends mostly upon the plant species present and intensity of their utilization. As the forage availability declines, the nutrient content in the diet declines. This is because reduced forage availability limits the ability of the animals to select a higher quality diet.

When browse species are high in the diet, the nutrient intake is generally high in protein, ash, lignin and ether extract. When grasses are high in the diet, the nutrient intake is generally high in cellulose, carbohydrates and metabolizable energy. Consequently, it is important to have a diversity of species on the range since the absence of one forage class may result in deficiency of certain nutrients. This may become a critical situation when the intensity of grazing is too great. This latter idea was supported by Cook et al. (1953) who indicated that on ranges producing a single species, increased intensity of grazing decreased the

nutrient content of sheep diet, but, on ranges supporting mixtures of species, intensity of grazing increased the nutrient intake in some cases.

FIGURE 2. Summary of Seasonal Preferences by Sheep (Severson and May, 1967).



Higher grazing intensities may result in lower diet quality in terms of nutrient content. Cook, et al. (1953) found that with heavier utilization, sheep diet on typical saltbush ranges of Utah contained a smaller percentage of the more desirable nutrients. Animals were forced to consume less nutritious portions of the plants which increase under heavy utilization. With heavy use, Cook et al. (1965) stated that the content of protein, phosphorus, cellulose and grass energy in the forage decreased, while lignin increased.

With regard to the effect of range condition and grazing intensity upon the nutritive value of sheep diet on mountainous summer range in Northern Utah, Cook et al (1965) found that the percentage of total protein in the diet was associated with increased intensity of utilization on both good and poor ranges (Table 3). The percentage of lignin was higher and the percentages of other carbohydrate and grass energy were lower in sheep diets under heavy utilization (Table 3). It is known that sheep are less selective under high intensity of grazing and they may consume coarser portions of the plants.

Furthermore, it has been shown that with continuous grazing, the nutritive value of sheep diet declines progressively (Cook et al., 1953). This suggests that sheep graze higher quality forage first. The nutritive value of the diet on a given range may vary greatly with seasons or years because of selective grazing and differences in environmental conditions.

TABLE 3. Average Chemical Content of Ingested Material of Sheep (Cook et al, 1965).

Range Condition	Intensity	Protein %	Lignin %	Cellulose %	Other CHo %	Gross Energy KCal/#
Good	Light	12.0	10.1	21.8	41.5	1954.5
	Heavy	11.4	10.4	22.2	40.8	1945.1
Poor	Light	13.0	10.2	19.7	42.4	1941.6
	Heavy	11.9	10.8	20.2	41.8	1929.7
Average	Light	12.5	10.0	20.8	42.0	1948.1
	Heavy	11.6	10.6	21.2	41.3	1937.4

Forage-Animal Relationship.

Grazing sheep need adequate food in sufficient quantity and quality to perform necessary processes such as growth of body tissues and reproduction. It is probable that the efficiency of animal production is influenced by the nutrient value of the forage available. On rangelands, range forage varies drastically from time to time and from place to place. Studies in central New Mexico showed range carrying capacity variations from 63 percent above to 61 percent below normal (Lantow and Flory, 1940). The seasonal distribution of precipitation means that seasonal fluctuation in food supplies will occur (Squires 1981); unreliable rainfall means that forage may be scarce for protracted periods.

The digestibility of range forage fluctuates widely from season to season. Burzlaff (1971) showed that during early growth stages range grasses are highly digestible but digestibility declines sharply as the season advances. Therefore, it is evident that range forage is inadequate nutritionally at certain times throughout the year.

Range livestock manifest different phases of growth throughout the seasons. Highest increases in animal body weight occur when the forage on the range is succulent and green with a high nutritive value. For instance, a study by Ahuja and Vishwanathan (1974) on growth of Chokla sheep in the rid zone of Rajasthan, India, indicated that different

grazing systems within the same period did not have any significant effect on the growth rate of the animals. However, the growth rate was found to be significantly affected by the season of the year. Bourbouze (1976) pointed out that average daily gain was only 300 to 500 gr per month for a mountain breed of sheep in active growth in a central High Atlas valley. He recorded high weight losses in ewes during the winter season, the most critical period in this area. Similarly, in Pine and Wah Wah Valleys, west of Milford, Utah, older ewes were subject to excessive weight losses during cold and stormy weather and recovered more slowly than younger animals (Harris, 1968).

In the arid zones, the primary cause of death of sheep is the shortage of food supply combined with stressful environmental factors. During exceedingly cold weather or hot summer or drought, losses in sheep flocks can be severe and often disastrous, especially in those regions where the sheepman is not well equipped to supply emergency feeding. For example, in the mountain ranges of Morocco, the producer can lose half of his herd during a severe winter season. Bourbouze (1976) recorded high mortality percentages within sheep herds when conducting a study in different valleys of the central High Atlas ranges (Table 4). The differences between years were due to climatic conditions.

TABLE 4. Mortality Percentages in Mountain Breed of Sheep (Bourbouze, 1976).

Animal Types	Zone					
	High Valley		Middle Valley		Low Valley	
	1974	1975	1974	1975	1974	1975
Less than 1 year (in % of ewes)	44%	-	40%	8%	27%	17%
More than 1 year (in % of animal more than 1 year)	37%	-	25%	6%	19%	7%

Squires (1981) identified food supply for the ewe as one of the major prenatal factors affecting the survival of lambs. He stated that Merino lambs weighing 2.0 Kg at birth have only a 33 percent chance of surviving. However, lambs weighing over 4.0 Kg at birth survive quite well.

Nutritional needs for wool production are relatively low compared to other physiological requirements. Therefore, wool types of sheep were developed on many areas of the arid regions. This point was illustrated by Ensminger (1977) to explain the predominance of the Rambouillet-type in southwestern United States. He reported that in general these ranges do not afford sufficiently good grazing to produce fat-market lambs at weaning time. Wool production with Rambouillet-type sheep, therefore, is of comparatively greater importance in this area than it is in other parts of the West. However, it is evident that a relationship between wool growth and forage availability

exists. For instance, Squires (1981) noticed when 400 to 450 Kg of oven dry green forage was available per sheep, the mean wool production approached 1.35 milligrams per square centimeter per day, but maximum wool growth was achieved when approximately 500 Kg of the forage per sheep was available. His study was conducted on Merino sheep in the semi-arid pastures of Australia.

Breeding ewes need high nutritional levels in early gestation, late gestation and lactation. Any major nutrition deficiency reduces fertility and causes reproductive failure (Squires, 1981). The problem of attaining adequate nutrition levels for optimum reproductive performances of sheep is quite serious in the arid regions. Bourbouze (1976) calculates the fecundity rate to be less than 80 percent during unfavorable years, while it can reach 96 percent during favorable years for the Mountain breeds of Morocco. Furthermore, the sparsity of forage on arid rangelands also can depress flock fertility. One important effect of food shortage is that sheep will disperse in small groups (Squires, 1981). This flock dispersion can seriously reduce the degree of contact between ewes and rams. It is important for the producer to choose the right mating periods to favor high fecundity and ensure lamb survival and growth.

CHAPTER 3

SHEEP IN MOROCCAN ARID RANGELANDS

Importance of Sheep Production in Morocco.

Livestock production is the most important agricultural activity in Morocco. More than 80 percent of the rural population depends on livestock production for their livelihood and livestock products account for more than 50 percent of the agriculture production of Morocco (Graves et al., 1978). By their relatively high number, sheep are of primary importance in providing meat, wool, milk and other products.

There are many reasons which explain the predominance of sheep in the agricultural economy. First of all, the large arid areas can only be economically exploited by the use of sheep as grazing animals. In addition, the Moroccan population prefers mutton and lamb to beef and goat, especially during religious holidays. Many producers consider sheep to be a source of prestige. They have no notion of productivity and the number of animals is the only consideration since it is a symbol of the social status of an individual. Sheep are a preferred source of income. They reproduce themselves and mature rapidly, so they have

the advantage of providing a quick cash return in relation to cattle.

The sheep population of Morocco has been increased over the past few decades. Stubbendieck (1978) reported that sheep numbers have more than doubled since 1930, while cattle and goats have increased by 67 percent and 68 percent respectively (Table 5). However, the sheep herds can experience high variability in number and many animals perish during droughts. During the terrible droughts of 1946-1947, 70 percent of all sheep perished in the arid regions of North Africa (Le Houerou, 1970). In 1980, the sheep population numbered 15 million, but numbers were subsequently reduced by around 40 percent following the last droughts (Mahin et al., 1982).

TABLE 5. Trends in Livestock Population in Morocco, 1930 to 1974) (Stubbendieck, 1978)

Type of Livestock	1000					
	1930	1940	1950	1960	1969	1974
Sheep	7,716	11,141	10,000	14,000	13,233	16,000
Cattle	2,039	2,050	1,900	2,800	2,964	3,400
Goats	3,392	6,487	7,000	7,000	6,879	7,000

Numerically, the sheep wealth of the arid regions of Morocco is impressive. However, lack of adequate feed resources and inadequate water resources are major reasons for their low productivity.

Importance of Moroccan Arid Rangelands and Their Role in Sheep Nutrition.

The rangelands of Morocco are those areas which by reason of physical limitations or sociological conflicts are not suited to cultivation. Forage for domestic livestock is their primary product. The Ministry of Agriculture has estimated that as many as 25 million hectares are rangeland and most of this area is arid or semi-arid. In the arid zones, more than 80 percent of the area is available for grazing (Le Houerou, 1970). Approximately 12 million hectares of Moroccan rangelands fall within the category called steppe vegetation and have an annual average rainfall range of 200 to 400 mm. Of this area 5 million hectares are collective lands and 3 million hectares are alfa grass (Stipa tenacissima) (Graves et al., 1978).

Most of the arid rangelands consist of common or collective lands. Each range is used by a group of families belonging to the same fraction or tribe. These families often live in the same province, or sometimes in two or more different provinces. However, contracts between people from different fractions or tribes can be made in order to gain access to certain lands. Furthermore, the delimitation of most of Moroccan arid rangelands and the number of users are not well known.

The arid rangelands support a combination of native plants growing in association. Such plants are generally

native and are adapted to the environment. Grasses, grass-like plants, forbs, and shrubs are commonly found in the arid rangelands, where they are suitable for grazing or browsing. However, their quality remains low due a short rainfall period. In the arid rangelands, drought problems occur basically through deficiency of rainfall in winter and spring. In favorable years these range can offer highly palatable species such as orchardgrass (Dactylis hisparrica), ricegrass (Oryzopsis miliacea), reedgrass (Phalaris troncata), and perennial ryegrass (Lolium perenne). In unfavorable years (low precipitation) they support a vegetation cover composed mostly of undesirable forbs and grasses and woody plants.

It has been estimated that the Moroccan arid rangelands contribute 70 to 80 percent of the total nutritional requirements of sheep. They carry an average of 10 million sheep and 3 million goats. The average stocking rate of these rangelands is approximately 1 ewe-lamb unit/hectare/year or 300 FU (Scandinavian Feed Unit = 300 Kg barley)(Graves et al, 1978).

Mostly, the arid rangelands are used continually for grazing without rotation and without feed reserves. There is practically no marked interchange between the raising of livestock in the arid lands and fodder production in the irrigated regions. In disaster years, the owners of livestock may buy feed at speculative and prohibitive prices

in the hope of insuring the survival of the animals (Le Houerou, 1970).

Some Characteristics of the Traditional System.

Transhumance. The variation of soil, climate, elevation, topography, and other factors cause variations in the availability of forage on rangeland. The quality and quantity of range species is governed mainly by rainfall which is erratically distributed over time and space. This situation leads the sheepmen to a "transhumant" life, moving with their animals in search of pasture and drinking water. Here the term "transhumance" is used because the producer has his fixed home where most of his family members spend the year practicing other agricultural activities, while one member or a herder moves the sheep herd to other areas.

This movement is a function of tradition, as well as the availability of forage and water. Generally, "transhumance" is practiced in a cyclic manner among plains, hills, and mountains. The ranges of low altitude are basically exploited during winter and spring. Late in spring or early in summer sheep are taken to higher altitude ranges or mountains. It is important to note here that significant numbers of animals, especially lambs and old ewes, may be lost during the movement, due to the long distances.

Reproduction. The rate of reproduction in the Moroccan arid regions is relatively low compared to other regions because traditional methods are used. Sheep will mate at any time of the year, because the rams are always associated with the ewes. The average number of ewes per ram was estimated to be 60 ewes (Bouyayachen, 1973). No supplemental forage is offered to the ewes during their reproductive cycle.

The ram is a product of the same herd in which he's designed to assure the reproduction. It is very common that females mate with males from the same ascendant or by the rams who sired them.

Rams are used for reproduction purposes from early age. Their selection basically depends upon phenotypic and morphologic characteristics. For the ewes, the selection is based on the morphology, production of milk, multiple birth, and wool quality. Ewes usually are immediately eliminated from the herd by sale or family consumption when they become too old or sterile.

The lambing period extends from October to April. However, the highest concentration occurs during January, February, and March (Table 6). This is a very critical period since it coincides with a food shortage and severe weather conditions.

TABLE 6. Percentage of Lambs Born, by Months (Bouyayachen, 1973).

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Total
4%	7%	10%	25%	20%	17%	9%	5%	1%	98%

Sheep Marketing. The structure of sheep marketing mechanisms is basically the same throughout the country. Sales are on a "head" basis. Buyers and sellers gather once a week in "souks" or local markets. Sheep brought to market are sold in an arrangement manner in which middlemen play an important role by facilitating the distribution process between the sellers and the buyers. The animals are not necessarily sold in their original zones, but they are transported in vehicles all over the country. Therefore, it is very common to find animals from all the regions in one marketing place. In some areas, due to lack of transportation and marketing system, animals are driven long distances to the market available, losing much of their weight during these journeys.

The financial needs of the livestock producer, rather than market prices, determine when livestock are sold. Before the market day, the stockman calculates his needs and decides the number of animals to be sold. The relative market value of sheep is determined by the condition of animals, sex, age, the number available in the market and the availability of forage on ranges. Such factors are largely attributed to consumer preferences and producer plans. Sheep and lambs prices tend to vary seasonally

through the year. In general the highest prices are recorded during the summer when the animals exhibit good condition due to the availability of forage in spring and early summer (Bouyayachen, 1973).

There are religious factors which influence marketing of sheep in Morocco. For instance, the religious feast, Aid el Kebir, has an important impact because 8 percent of the annual sheep slaughter and 20 percent of the annual sheep commercialized are associated with this feast (Bouyayachen, 1973). The animals preferred on this occasion are generally males. In some cases the buyers are not necessarily livestock producers or packers, but are speculators who buy the animals and keep them for a short period of time and then sell them in favorable regions.

Unfortunately, there is little government involvement in controlling the provenance, destination, and diseases of the animals marketed. However, buyers and sellers have to pay significant taxes ranging from 0.5 to 1 DH per head (1973) according to norms established for each region. The money collected goes to the "commune" which possesses the "souk" (Bouyayachen, 1973).

Causes of Rangeland Deterioration.

Low livestock production levels and poor condition ranges are generally found throughout the arid regions of Morocco. The arid rangelands have been overused to some degree, and their basic productive capacity thereby lowered.

Le Houerou (1970) indicated that the present vegetative cover in these lands is very much below the potential of the climate. Overgrazing by livestock in conjunction with other human activities is the major contribution to range deterioration and soil erosion.

Overgrazing by Livestock. Since the dawn of history grazing has been the pattern of life throughout the arid regions which provide man with accessible rangelands for his animals. However, these ranges often have been grazed improperly. Over-stocking combined with the lack of rotational grazing or range deferment has been considered to be the main cause of range deterioration. Unfortunately, the lands available in the arid regions of Morocco have been subject to continuous and heavy grazing which has resulted in a great depletion of vegetation. Consequently, their carrying capacities have been very much reduced. The result is low quality forage of insufficient quantity to support the present livestock population.

Ranges are grazed in a manner in which little residue is left. This does not allow the range to continue normal production. The increase in livestock numbers in relation to available forage has resulted in relatively severe over-grazing. It is known that heavy and continuous grazing reduces the capacity of the range and causes undesirable vegetation changes. Grazing during critical growth stages may harm only certain species, while others may be benefited

because of reduced competition. Consequently, the range vegetation of palatable and nutritious plants is replaced by less desirable plants.

The instability of life and lack of property rights are also major causes of overgrazing. Stockmen seek to cope with the scarcity of forage by moving their livestock seasonally or as circumstances require in search of forage. But this too has brought its problems: conflict among rangeland users, especially where land tenure is unclear or undefinite, and overuse of the favorable ranges.

Furthermore, common land ownership and free grazing contributes in a large degree to over-stocking. Each member of the collectivity has the right to graze as many animals as possible and cannot prevent others from over-stocking. The owners have no notion to use the vegetation to assess livestock carrying capacity. However, they have strong competition for grazing.

Over-grazing on a range is not entirely dependent upon the number of animals. It can occur if stock are not distributed properly. In the arid rangelands of Morocco water distribution is likely to be the major factor that influences livestock distribution on the range. Range damage is most severe around watering points.

Other Human Actions. The arid regions of Morocco were sparsely populated in the past, but more recently the presence of an increased population has brought an influx of

settlers and the construction of many permanent villages. As the population grows, its food requirement and other needs increase and its sedentarized pressure on the land increase proportionately. The ecological result of such changes is a progressive degradation of the system (Wagner, 1976).

Other human influences on the eco-system are: grain cultivation and vegetation harvest for fuel, building material, and livestock fodder. Extensive clearing of the native vegetation on rangelands is widely practiced. The primary purpose of clearing is for cultivation of subsistence crops. No clearing of the undesirable plants is practiced for range improvement purposes. The yield of grain crops is very low, averaging less than 300 Kg per hectare (Le Houerou, 1970). Selective wood removal for fences and construction is also widely practiced. A serious problem related to the cleared land is soil erosion. On cleared lands, the reduced ground cover will increase soil losses due to water erosion, especially in those areas where rain storms are very intense. Even so, significant parts of the vegetation in the more productive areas can be cut for hay and winter feeding.

In general, the rangeland vegetation and environment have gradually deteriorated because of plowing, overgrazing, and the harvest of woody species. These are a result of population growth, agriculture mechanization (introduction

of the tractor), increased cereal farming, and sedentarization of the population. Consequently, the grazing lands are decreasing in quantity and quality.

Constraints to the Development of Moroccan Rangelands.

The first governmental step to stop rangeland deterioration occurred when the creation of range management perimeters were authorized by law in the Dahir 1-69-171 in July 1969. Several agencies of foreign governments have been involved in the formation and implementation of range policies in Morocco for nearly 20 years. However, results have been much less than desirable and development work in pastoral areas has frequently been associated with many problems. All solutions have been short lived or, on the other hand, have failed from the beginning. The basic barriers to development are derived from administrative, social, and economic constraints.

The land is allocated to certain social units (sometimes widely dispersed in space) called "tribes" by the administration. This form of land tenure leads to the fragmentation of decision making among users and this results in a lack of uniform management practices and is a major barrier to adequate information and programs. Many people have no awareness or interest in developing the total collective lands belonging to a particular social unit.

In order to be successful and beneficial, any program must be evaluated from the client's viewpoints. The Moroccan stockmen, in contrast to government, are much more diverse in their points of view. Some individuals are quite traditional in the sense of desiring that no change take place in their life-style. Unfortunately, what is desired by the leaders differs to a considerable degree from what is wanted by the individuals in the community. The major interest of the latter is the welfare of their families and not the society as a whole.

Historically, the livestock producers developed a traditional system to fit their unique needs and situation. To create change in the community through the introduction of technological innovation is difficult. Any solution proposed seems to be mal-adapted to the local situation, especially when the new ideas are originated from other environments. Therefore, the clients react most directly, and with the greatest rapidity, to changes in the natural environment. For instance, Paul Bartel (1982) pointed out that importing a technology or a set of ideas from one environment to another is not only ethnocentric but also unfair to the client population.

The social problems are not well identified and analyzed. Additional actions are needed to understand and solve these problems. It is clear that the tribe has been able to gather itself together for collective actions. But

this solidarity may have little permanence. This presents a challenge to effective administration (del Castillo, 1982). Del Castillo added that the French found this to be so when trying to establish their control over the Moroccan regions. The problem facing range management doesn't have the colonial aspects of the French occupation, although the problem remains when trying to establish some control over rangeland use, whether it originated from within the tribe or from external sources.

The lack of the availability of local technicians and effective extension services in the field of range management is one of the important problems that contribute to the failure of programs of development. Most of the technicians who are involved in range management programs are trained in animal health. In addition, the technicians and engineers are educated in French or English and neither of these two languages is spoken by the stockmen. Furthermore, there are five Berber dialects spoken in the country. In many cases, the technician or engineer doesn't speak these dialects. This prevents clear communication and good understanding between the change agents and the producers.

Most of the Moroccan farmers and ranchers are illiterate. They cannot read newspapers, magazines and other forms of information. They also have strong religious beliefs. For instance, they believe that rangelands are

created by God and He is the only one who can improve them by giving great amounts of rain and no improvement techniques are necessary.

Prior to the last two decades the development of rangelands and livestock did not receive the greatest support from the government. However, much attention was paid to other productive schemes because they have great value for foreign exchanges. Rangelands are dispersed forms of land use. They are characterized by their isolation and lack of transportation. This geographic barrier contributes to both the high cost of operating and the cost of implementing change.

Example of Range Improvement.

Larid Perimeter will be taken as an example, because it is the only perimeter in which range activities are clear and well defined and it constitutes a solid example for comparison with other perimeters in the country. In addition, there are some factors of sociological origin which limit its proper management.

Larid Perimeter consists of 12,000 hectares of native range administered as collective land tenure. It is located in the steppic High Plateau on the eastern side of the Middle Atlas mountains at 1660 meters elevation. The area receives total precipitation of 300 mm annually which falls between October and May. The vegetation is predominated by sagebrush (Artemisia herba alba) and alfa grass.

This perimeter is a result of a U.S.-Moroccan project started in 1968 by field adaptation trials of range plant species and varieties, developed in North America including grasses, forbs, and shrubs. The perimeter, then, has been seeded with tall wheatgrass (Agropyron elongatum), crested wheatgrass (Agropyron cristatum), and intermediate wheatgrass (Agropyron intermedium), species that showed best biological adaptability under the local environmental conditions. Some area of the perimeter were opened for grazing in 1979. The grazing season occurs between April and November. Considerable improvement in sheep production was obtained. For instance, Graves et al. (1978) made a 6 month comparison of ewe-lamb grazing treatments. Ewe-lamb pairs were stocked at 1.0, 2.5. and 2.7 ha/pair. Grazing treatments were crested wheatgrass rotationally grazed, native range rotationally grazed, and native range traditionally grazed. Significant improvements in average lamb weight gain and total ewe-lamb meat production were observed (Table 7).

The method of grazing management practiced has not been adequate for the seeded perimeter. Consequently, overgrazing signs have been observed. Total sheep numbers exceed perimeter carrying capacity. Stocking rates are established each grazing season by the responsible

TABLE 7. Ewe-Lamb Production Under Three Different Management Systems During Six Month Grazing Trial (April 19 to October 19, 1971) - Larid Plain (Graves, 1978).

Management	Flock Average Weight (Kg) and gain (Kg)						
	Lamb Weight		Lamb Gain	Ewe Weight		Ewe Gain	Total ewe-lamb Meat Production Kg/ha
	Apr 19	Oct 19		Apr 19	Oct 19		
Crested Wheatgrass rotationally grazed	6.9	25.0	18.1	23.0	29.0	6.0	45.7
Native Range rotationally grazed	6.9	21.9	15.0	23.5	28.5	5.0	16.0
Native Range traditional management	6.6	17.8	11.2	23.3	28.3	5.0	9.0

technicians, but total sheep allowed to graze on the area are submitted to local authorities who give grazing permits to the users.

Because of water scarcity, pastures far from water were either totally ungrazed or only moderately grazed while others were severely damaged and needed to be reseeded. In a 4.5 Km transect, Goebel (1982) found great variation in animal distribution where counting numbers of clusters per plot. Using this method he also found sign of other animals on the perimeter, while the range is designed only for sheep grazing. Goebel (1982) indicated that good plant vigor was recorded in sections of the transect far from water, and some erosive activities were noted in some sites.

Serious problems are sometimes created by the users. For example, during the drought of 1981 perimeter users insisted that livestock remain on over-grazed pastures. Flocks were maintained, but some pastures were permanently destroyed and others were left with low plant vigor. Consequently, the perimeter was closed to grazing for the 1982 season. A grazing indemnity of 200 metric tons of barley from the Ministry of Agriculture was distributed in fall 1982 to the users as a result of exclusion of the perimeter from grazing for the 1982 grazing season (Morocco Range Management Project, 1982).

CHAPTER 4

CONCLUSIONS AND RECOMMENDATIONS

It has become clear that malnutrition is the primary constraint to animal production and over-grazing is the major cause of range deterioration in the arid regions of Morocco. The objective of sheep and range management should be to analyze the existing management practices and to suggest economically sound measures for better profit to the Moroccan ranchers. Some of the recommendations which would achieve the desired impact on sheep nutrition, are summarized in very general terms.

More attention should be paid to the sociological and organizational aspects of change, because these are the major constraints to development. In addition, the identification and analysis of the socio-economic variables in the traditional system should be investigated.

Serious thought should be given to the adoption of a sheep nutrition program and management on a massive scale in the arid region of the country. At this point extension efforts are necessary to assist the producer toward desirable change. This may be achieved by the establishment of demonstration stations where the producers can examine, understand and evaluate the role of optimum stocking rate,

the impact of overgrazing on plant health and the benefits of an adequate grazing system. The education of the producers is the most effective tool for change and it is necessary for effective application of modern technology.

It is essential to convince the people to stop immediately the clearing of rangelands for grain cropping and other purposes. Any such land use conversions should be studied very carefully before implementation (Taylor, 1977).

Each range area should be delineated and the number of its users should be known. Complete range surveys and inventories are of great importance. The determination of range carrying capacity should be based on feeding preference and animal requirements. Grazing behavior of sheep should also be studied.

To increase livestock production and reduce rangeland deterioration, it is primarily a question of reducing the livestock number and exploiting rangeland rationally by rotational grazing or range deferment. This will not be achieved unless change in land tenure and sedentarization of the transhumants take place. Animal numbers should be adjusted to the availability of range forage and its fluctuation over the year. Furthermore, interchange between the arid and irrigated regions should exist to balance feed deficiency during the critical period.

Supplying drinking water is one of the major economic outputs needed for the development of sheep in arid

rangelands of Morocco. The watering points should be located properly to control the movement, distribution, and concentration of the animals. The frequency and distribution of watering points should be such as to utilize all the pasture.

Controlling the breeding season is one of the more important practices that is feasible. This can result in decreasing the mortality of new born lambs and improving growth rates.

The fact that sheep predominate in the arid zones is probably ecologically and sociologically determined. The productivity of sheep depends largely on what is available on rangelands. At present these ranges produce less than their capacity and they cannot support the present livestock population. When a drought hits the arid rangeland, both man and animal suffer. It is time to recognize the value of proper management of the vast arid range areas. We are forced to satisfy the needs of a population expected to increase dramatically by the year 2000. These demands must be met without disturbance of the arid range eco-system.

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