

Grazing and its Influence on Vegetation and Soil in the Highlands of the Asir Region, Saudi Arabia

Dr. Marei Hussain Al-Qahtani



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Abstract:

Based on the field survey and observation, interviews with shepherds and owners of livestock, measurement of weeds and grass height as well as measurement of perennial vegetation and analysis of soil properties, the research area can be divided into two distinct grazing zones, namely the mountainous grazing zone which extends along the western and the south-western boundary of the research area, and the plateau grazing zone which covers a wide area in the north-eastern portion of the research area. The influence of over-grazing on vegetation and soil condition appears to be clear, particularly in the plateau grazing zone. Comparison between vegetation and soil features in the mountainous grazing zone, where there are fewer livestock, and the plateau grazing zone, where there are more livestock, indicated that the condition of vegetation cover and soil in the plateau grazing zone is very degraded compared with their condition in the mountainous grazing zone.

1. Introduction

Despite the dwindling of grazing activity in Saudi Arabia since the discovery of oil, which has led to an increase in national and individual income, the Asir region, which includes the research area, has remained one of the important grazing regions in Saudi Arabia. According to the most recent statistics (1996) (compiled by the Ministry of Agriculture and Water, Saudi Arabia), the Asir region includes 1,166,472 goats, 1,512,471 sheep, 21,188 cattle and 29,936 camels. By comparing these numbers of livestock in Asir

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region with those for the country as a whole, which encompasses 13 statistical regions, the importance of grazing activity in the Asir region can be seen clearly (Table 1 and Fig. 1). As can be seen from this Table and Figure, the Asir region contains 27% of the country's goats, 26% of its sheep, 14% of its cattle and 7% of its camels. However, the distribution of livestock within the Asir region is not known as yet, nor has the influence of grazing on soil and vegetation in the research area been studied.

Table 1: Comparison between livestock numbers in Saudi Arabia and Asir region.

Area	goats		sheep		cattle		camels	
	number	%	number	%	number	%	number	%
Saudi Arabia	4308509		5856394		147046		415468	
Asir region	1166472	27	1512471	26	21188	14	29936	7

(Source: Agriculture Statistical Year Book (1996), Ministry of Agriculture and Water Saudi Arabia).

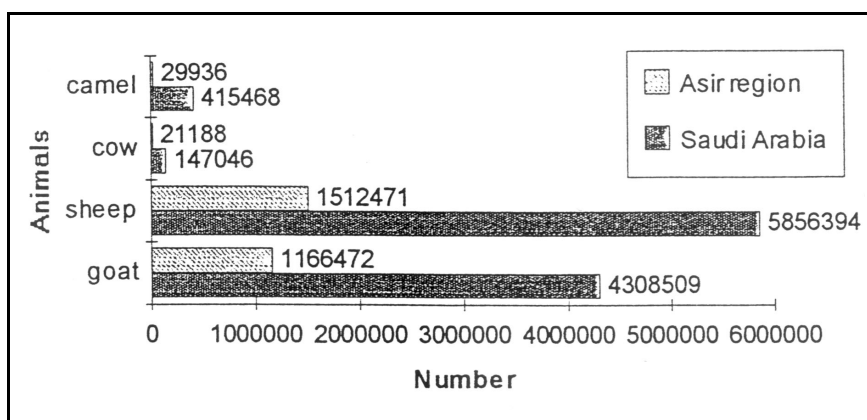


Figure 1 Livestock numbers in Saudi Arabian and Asir region (1996)*.

* Source Agriculture Statistical Year Book (1996), Ministry of Agriculture and Water Saudi Arabia.

Studies of grazing in Saudi Arabia in general and in the Asir region in particular have received little interest and attention from scientists and researchers. There was a limited amount of information, including some descriptive signals and field observations. However, the few previous works that were conducted in the research area or in its surroundings have confirmed that overgrazing has led to clear changes in vegetation and soil formation. For instance, the studies of Al-Saleh & Abu Al-Aula (1977) and Al-Hassan (1993) related the deterioration of pasture in Saudi Arabia to drought, overgrazing, wood-cutting and increase of soil salinity. Also of interest are the studies of Abulfatih et al. (1989) and Hajar (1993) who compared protected and grazed areas. The first study was carried out in the Asir region and examined the vegetation and pasture status. This study revealed that the protected area had higher species diversity, plant biomass, plant heights, soil carbonates cation exchange capacity and electrical conductivity, whereas the grazed area contained relatively lower plant biomass, plant heights, soil water content, organic matter and total nitrogen. The second study was carried out in Al-Bahah region, to the north west of the research area. This study revealed that the protected area maintained a higher species diversity and more edible plants, whereas the grazed area had a low cover, and consisted mainly of non-edible and damaged species.

The Study Area

The Asir highlands occupy a unique position in the south-west of Saudi Arabia and cover an area of about 10,000 sq Km (See Figure 2). In terms of geographical location, the Asir highlands lie in the zone between 18°-20° N latitude and between 42° 10' - 43° E longitude. Geologically, the study area belongs to the greater Afro-Arabian shield which is a part of the Precambrian crystalline plate (Schmidt et al, 1973). The elevation of the area above sea level ranges from 1000 m to 3130 m (Al-Shareef, 1984). It contains mountains, escarpment, deep valleys, rolling land and rocky hills (Abulfatih, 1981). The area is distinguished by moderate temperature

throughout most months of the year. Although there is a decrease in temperature in winter, it does not reach freezing point, because this area faces the warm marine wind. An important factor, is that this area receives high rainfall. These rains are distributed throughout the year with peaks in spring and summer (Al-Shareef, 1976 & 1994).

Methods and Procedures

During the summer of 1998, a detailed survey was completed by the researcher. This survey involved thousands of kilometres of inland travel in the Asir highlands. During this survey, the effect of grazing, which can be considered as the only human factor affecting soil and vegetation cover, was observed, particularly in the north-eastern part of the research area. For this reason, sixty interviews were later conducted with shepherds and livestock owners (30 interviews in the north-east of the research area; and 30 interviews in the south-west) (see Table 2, 3 & 6). Each interview with shepherd or livestock owner was taken randomly from each transect. In order to collect data on vegetation and soil, 60 transects were selected systematically as profile lines along the eastern-slopes of Asir region. These transects covered all the physiographic and physiognomic variations of the region. Along each transect, five samples of vegetation and soil were collected using point-centred quartered methods. These methods have been explained in many text books and applied in many scientific researches, such as Kershaw (1973), Mueller-Dombois & Ellenberg (1974), Goldsmith et al. (1986) and Kent & Coker (1992). The heights of weeds and grasses in each sample stand were measured. As well as measurement of absolute density, relative covering value and heights of perennial vegetation, analysis of soil characteristics was undertaken (see Tables 4 & 5). Based on these data and information, a picture was formed of the pattern of grazing and its influence on soil and vegetation in the highlands of the Asir region, are discussed below.

Results and Discussion

During the field survey, in June 1998, several important

observations were made of grazing and its zones. Based on these observations, interviews with shepherds and owners of livestock, measurement of weeds and grass height as well as measurement of perennial vegetation, it appears that the research area can be divided into two distinct grazing zones, namely the *mountainous grazing zone* (in the west and the south-west) and the *plateau grazing zone* (in the east and the north-east) (fig.2). The following paragraphs discuss the grazing status in these zones.

Grazing Status in the Mountainous Zone

This zone extends along the western and the south-western boundary of Asir highlands, approximately from Tanomah and Belesmer to Abha and Khamis Mushayt, and on the east and north-east it is bounded by the plateau zone. Elevations in this zone range from about 2000 to 3130 m above sea level. Rainfall is in the range 300-500 mm annually. The average temperatures in this zone are the lowest in the research area (about 17 °C) and average relative humidity is about 55%. The landscape is generally dominated by mountains with occasional very narrow valleys.

Since the discovery and exploration of oil in Saudi Arabia, the number of nomads has decreased rapidly and most Bodouins have successfully exchanged nomadism for an urban environment, particularly in the mountainous grazing zone mentioned above. Table 2 indicates the results that have emerged from the 30 interviews carried out with shepherds and owners of livestock herds in the mountainous grazing zone. The average size of herds in this zone is 39. 56% of the livestock are goats, 43% sheep, only 1% cattle and no camels are found in this zone. The majority of respondents (60%) indicated that their purpose in livestock breeding was personal use and self sufficiency, while 40% of owners kept livestock for both personal use and local commercial marketing. Only 7% of herd owners depend completely on the livestock as their only source of income. The other 93% of herd owners had various other sources of

income, including employment by government institutions, and their own businesses.

As regards downgrading of grazing, opinion was split. 60% of respondents indicated that the pastures in the mountainous zone were enough to support their livestock all year round, whereas 40% thought that additional forage is needed to feed their livestock. However, only one respondent (3%) moved his livestock northward in search of new pastures during the winter. Weeds and shrubs such as **Cenchrus ciliaris** and **Cymbopogon Schoenanthus** are the favourite pasture plants in this zone (Hajar, 1993). 67% of respondents emphasized that their livestock, particularly the sheep, eat weeds and grass, while 33% indicated that their livestock eat both weeds and shrubs. Although the mountainous grazing zone receives more than 300 mm of annual rainfall, only 16% of herds are watered entirely from rainfall water; 48% are watered from supplies transported in by cars and water tankers, while 27% and 9% are watered from wells and springs respectively. This finding can be related to the increase of slope gradient which leads to increased velocity of runoff from this zone toward the desert. These indications suggest that grazing in the mountainous zone is not intensive and its main purpose is to provide some of the food requirements of the inhabitants of the area.

Grazing Status in the Plateau Zone

This zone covers a wide area in the north-eastern portion of Asir highlands (Fig. 2). Elevations in this zone range from about 1000 to 2000 m above sea level. Temperatures are higher than in the mountainous zone (25 °C), while rainfall is less both in intensity and frequency (100-120 mm annually). The average relative humidity is about 40%. The topography is variable with a generally dissected and rolling aspect and with widespread rocky hills and rock outcrops of low relief.

As can be seen from Table 2, the results that emerged from the 30 interviews carried out with shepherds and owners of livestock

herds in the plateau grazing zone indicate that the average size of herds in this zone (171) is much larger than in the mountainous zone. Of these, 83% are sheep, 9% goats and 8% camels and donkeys.

These animals roamed the plateau zone and its surroundings in search of rich vegetation cover. The majority of respondents (93%) indicate that they bred livestock for both personal use and commercial marketing, while only 7% of owners keep livestock purely for personal use and self sufficiency. This finding is different from that found in the mountainous zone. As shown in Table 2, 70% of herd owners depend completely on livestock as their only source of income, while 30% of owners have other sources of income. One of the most important findings is that all respondents indicated that natural vegetation cover in the plateau zone is not enough to feed their livestock all year round. Therefore, 50% of herds are moved, particularly during the autumn and winter seasons, to those areas located toward the north and the east of plateau zone, in search of new pastures. The other livestock owners (50%) indicated that they import forage for their livestock from the local markets. The responses of shepherds and owners of livestock (Table 2) indicated that trees, shrubs and weeds such as **Acacia arabica** and **Commicarpus grandiflous** are favoured by all kinds of livestock. Due to the drilling of water wells, and the availability of cars and water tankers, the majority of shepherds and owners of herds reported that their livestock did not suffer any shortage of water.

Overall, the increase of grazing in the plateau zone can be related to the simplicity of transport, increased percentage of sheep and camels, availability of water wells and preference for this zone as a connection zone between the mountainous zone and the desert. Availability of roads and tracks in the plateau zone makes it easy for the Bedouins to move their animals in search of pasture and water. Most of the herds in this zone are sheep and camels, which face some difficulties in movement in the mountainous zone. The Bedouins prefer this zone because it enables their animals to graze

in the margins of the mountainous zone (in the south-west) and the desert (in the north-east).

From this information, it is possible to say that grazing is an essential occupation for most inhabitants of the oases, villages and wastelands of the plateau zone.

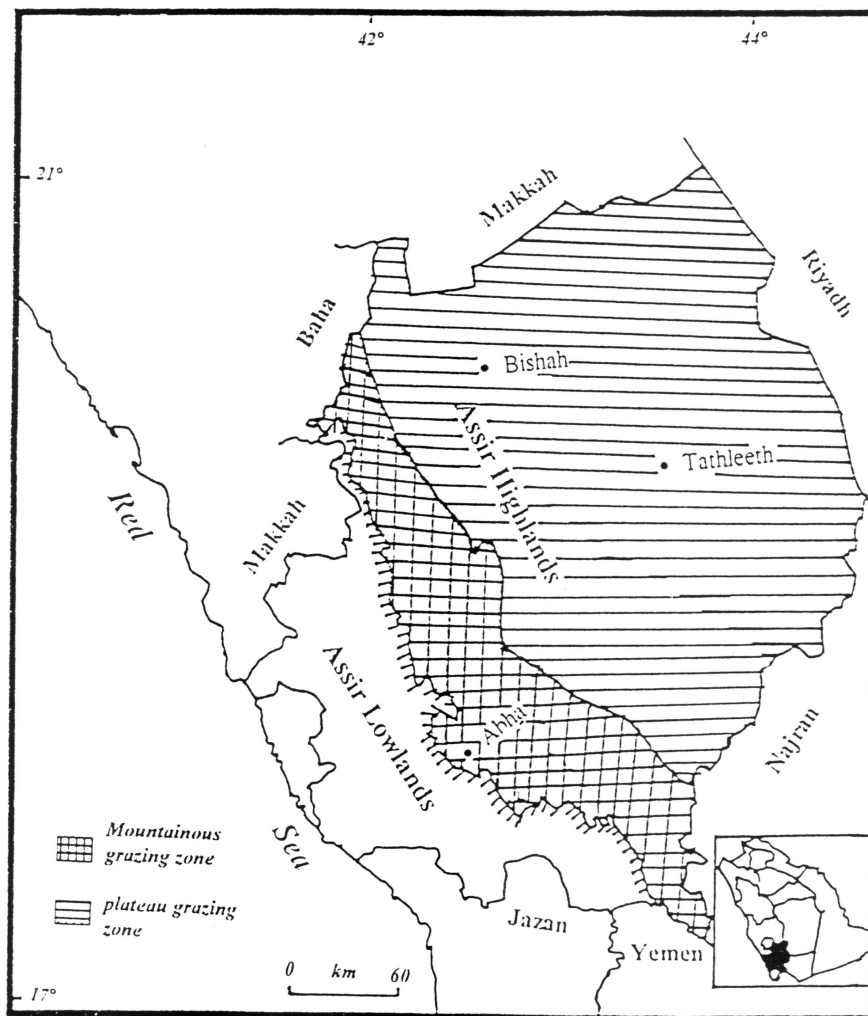


Figure 2 Location and Grazing Zones of Asir Highlands.

Table 2 Summary of Responses of Shepherds and Owners of Livestock on the Level of Grazing in the Research Area.

Question	Reponse	Mountainous Grazing zone %	Plateau grazing zone %
What kind of animals and how many do you have?	Sheep Goat Camel Cow Donkey	43 56 1	83 9 8
What is the purpose (s) of breeding these livestock?	Personal use Personal and commercial	60 40	7 93
Does your income depend only on livestock breeding or do you have another source of income?	Only from livestock breeding Livestock and other sources	7 93	70 30
Is the pasture in your current area sufficient for feeding your animals?	Sufficient Insufficient	60 40	 100
Do you move your animals to other areas?	Yes No	3 97	50 50
What is/are the reason (s) for movement?	Look for new pasture Look for water	100	71 29
In which direction do you usually move your animals?	Norht South East	100	60 40
In which season (s) do you move to the new grazing?	Spring Winter Autumn	100	13 54 33
*What kind (s) of vegetation do your animals depend on for grazing?	Trees Shrubs Weeds	 33 67	20 37 43
What kind (s) of water source (s) de you use for your animals?	Wells Rainfall Water Springs Water Transported by cards	27 16 9 48	41 24 35

(*) For further details, see text.

Influence of Grazing on Vegetation and soil

Grazing in general, and over-grazing in particular, has been regarded as the prime cause of desertification and environmental degradation, especially in arid and semi-arid areas (Goudie, 1990; Hajar, 1993). This idea also has been demonstrated at the local level in Saudi Arabia by Draz (1965) and Abulfatih et al. (1989). Until the beginning of the second half of the twentieth century, most of the research area was located under the *hema*⁽¹⁾ system, which supported the growth of vegetation cover. After the establishment of Saudi Arabia (1932), and due to the problems between the tribes resulting from application of the *hema* system, the government of Saudi Arabia abandoned this system in 1953 (Al-Welaie, 1996). Since that time livestock, particularly sheep, goats and camels, have roved the research area in search of rich vegetation cover all year round. Unfortunately, despite the decline of nomadism during the last few decades, the vegetation cover has decreased due to uncontrolled grazing. This is especially the case for the favourite plants for animals in the plateau grazing zone in the north-east of the research area.

It is known that there are several factors which influence deterioration of vegetation cover and soil, but over-grazing and mismanagement of range-lands are the main factors contributing to deterioration of natural vegetation cover and soil in the area under study.

As was mentioned earlier, the vegetation and soil of the research area have suffered from several impacts, such as reduction of rainfall, augmentation of slope gradient and over-grazing. Therefore, five questions on these matters were asked to shepherds and owners controlling livestock (Table 3). As can be seen from this Table, 50% of shepherds and owners of livestock do not know the impact of livestock on vegetation and soil. The other 50% of shepherds and owners realize thatt their livestock influences the disappearance of vegetation (71%), the fatigue of pastures (23%), crumbling of soil (3%) and increase of soil fertility (3%). However,

(1) The *hema* system means protection of the lands from grazing and wood-cutting, particularly those lands on which rain has recently fallen. It is a full regulation established between and by the tribes living in the region, and aims to protect and conserve the pastures and plants from random exploitation, especially during growth periods. It prohibits grazing in protected lands, except in special circumstances, such as a drought. This system was applied between the tribes till 1953, particularly in the western and the south-western regions of Saudi Arabia.

72% of shepherds and owners of livestock who know the impact of animals on vegetation and soil believe that stopping wood-cutting and protection of soil and vegetation against fire and pollution are the best ways to conserve them. Despite the relatively limited impact of wood-cutting, fire and pollution on vegetation and soil of the research area, the shepherds and livestock owners obviously preferred to blame these factors rather than their animals and their grazing methods, for deterioration of vegetation and soil. It can be noted that the contribution of the shepherds and owners of livestock in avoidance of over-grazing is very weak. In interview, 48% of them said they made no effort to avoid over-grazing. The others tried to avoid it by buying forage (48%) and moving to a new grazing land (52%) during drought seasons.

In fact, the influence of grazing on deterioration of vegetation and soil in the research area appears to be clear, especially if the vegetation features (Table 4-17) and soil characteristics (Table 4-18) in the mountainous grazing zone and plateau grazing zone are compared. The following two sections deal with this subject.

Table 3 Summary of Responses of Shepherds and Owners of Livestock on the Influence of Grazing on the Vegetation and Soil in the Research Area.

Question	Resonse	%
Do you know, what is the effect of livestock on vegetation and soil	Known	50
	Unknown	50
What kind (s) of effect do livestock have on vegetation and soil?	Increasing of soil fertility	3
	Crumbling + expousure of soil	3
	Crumbling of vegetation	71
	Fatigue of grazing	23
What can be done to conserve the vegetation and soil?	Protect soil and vegetation against fire and pollution	25
	Stop wood-cutting	47
	Unknown	28
Do you try to avoid over-grazing?	Yes	52
	No	48
How do you avoid over-grazing?	Move to new grazing land	52
	Buy forage	48

Influence of Grazing on Vegetation

Mutual impacts can be recorded between livestock and vegetation cover in the research area, but the distinct impacts are the following.

It has been recognized that grazing animals eat particular plants or graze particular plant communities with relish and reject others such as **Juniperus Procera** and **Calotropis procera**. Sheep and goats select the leaf in preference to the stem and green (or young) material in preference to dry (or old) material. Younger material may be preferred because it is generally shorter or because it differs in chemical composition from older material (Arnold, 1964). These selective actions cause more destruction to the vegetation cover because the leaves and green materials are the active parts which support continuance of plant growth. Camels also graze and eat the higher stems and branches of trees and shrubs such as **Acacia arabica**, **Acacia gerrardii**, **Acacia negrii**, **Tamarix aphylla**, **Lycium barbarum** and **Lycium shawii**. They are able to break down the branches of plants and get access to leaves that are out of the reach of sheep and goats.

Due to over- grazing, some palatable species such as **Commicarpus grandiflous** and **Periploca aphylla** have disappeared, while the less palatable and poisonous specie such as **Solanum incanum** and **Solanum schimperianum** have occupied their places in several parts of the research area, particularly in the plateau grazing zone. This can be related to grazing during the earlier stages of plant growth, which leads to loss of seeds and finally, to cessation of regeneration. The effect of over-grazing, mainly by sheep and goats, can be seen clearly in the vicinity of water sources (mostly wells in the plateau zone and springs in mountainous zone); vegetation cover is almost absent from the areas that surround these sources.

As can be seen from Table 4, the mean size of livestock herds (171) is much higher in the plateau grazing zone compared with that (39) in the mountainous grazing zone. This finding, as well as field

observations collected by the researcher, indicated that the plateau zone contains far more livestock than the mountainous zone. The comparison between vegetation features in these zones shows the following:

- 1 - Absolute density of the perennial vegetation was relatively higher in the mountainous grazing zone (3.01/100 m²) when compared with that in the plateau grazing zone (2.46/100m²).
- 2 - Relative covering value in the mountainous zone (32) was more than double that in the plateau zone (13.21).
- 3 - Trees and shrubs were generally taller in the mountainous zone (Table 4).
- 4 - Mean height of weeds and grasses in the mountainous (17.25 cm) was much higher than that in the plateau zone (5.41 cm).

Table 4: Vegetation Features of Grazing in The Research Area

Grazing zone	Mean herd	Vegetation features			
		absolute density	relative covering value	mean trees and Shrubs heights m	mean weeds and grass height cm
Mountainous zone	39	3.01	32	1.79	17.25
Plateau zone	171	2.46	13.21	1.61	5.41

Influence of Grazing on Soil

Livestock and over-grazing influence soil either directly or indirectly. The direct impacts are seen in the trampling of livestock on soil materials, soil flakiness, soil abrasion, soil exposure and supply of organic matter. The indirect impacts are represented mainly by the influence of livestock and over-grazing on vegetation cover and finally on soil. It is known that vegetation cover acts as a protective layer or buffer between the atmosphere and the soil. The above-ground components, such as leaves and stems, absorb some of the energy of falling raindrops, running water and wind so that less is directed at the soil, whilst the below ground components, comprising the root system, contribute to the mechanical strength of the soil (Morgan, 1995). The problem of soil erosion is a natural

result of plant disappearance. However, this problem becomes more serious when the grazing zone is located on hill-slopes, where soil erosion is faster and accumulation is less (Hajar, 1993).

As mentioned earlier, the plateau grazing zone supports a larger livestock population than the mountainous zone. The comparison between soil properties (Table 5) in these zones shows the following.

- 1 - Soil mechanical analysis carried out by the hydrometer method showed that soils of the mountainous grazing zone were generally loamy sand, while those of the plateau grazing zone were mostly sandy loam to sand.
- 2 - Due to the decrease of slope gradients, the soils were somewhat deeper in the plateau zone (Table 5).
- 3 - Physical and chemical analysis revealed that moisture content, organic matter, organic carbon, nitrogen and phosphorus were much higher in the soils of the mountainous grazing zone than in the soils of the plateau grazing zone.
- 4 - Also, chemical analysis revealed that CaCO₃, potassium, pH and electrical conductivity were higher in the soils of plateau grazing zone, compared with the soils of the mountainous grazing zone.

Table 5 Chemical and Physical Characteristics of Soil in Grazing Zones in the Research Area.

Grazing Zone	Mean	Soil properties									
	herd	soil depth	moist-ure	OM	OC	Ca-CO ₃	N	P	K	pH	EC
Mountainous zone	39	30.07	3.47	1.51	0.88	2.09	496.03	54.03	91.41	8.12	0.27
Plateau zone	171	32.55	1.45	0.71	0.41	3.60	227.42	43.02	140.45	8.40	0.51

Overall Effects: Deterioration of Grazing

In order to avoid the deterioration of grazing which leads eventually to deterioration of vegetation and soil status, it must first be known what is/are the reason (s) for deterioration of grazing in the research area? This question was asked to the shepherds and owners of livestock herds. Their responses (Table 6) indicated that

increasing of livestock, weakness of the traditional *hema* system (see page 5), wood-cutting and weakness of planning for exploitation of pastures are the main reasons for deterioration of grazing, while decreased rainfall, over-grazing, governmental support to the Bedouins⁽²⁾, concentration close to water resources and increased Bedouin movements are lesser reasons. However, from the available evidence, the author thinks that the government support and over-grazing are the main reasons for deterioration of grazing, vegetation cover and soil status.

Table 6 Summary of Responses of Shepherds and Owners of Livestock on the Reason (s) for Deterioration of Grazing in the Research Area.

Question	Response	%
What do you think is/are the reason (s) for deterioration of grazing in your current area?	Decreasing of rainfall	7
	Increasing of livestock	22
	Weakness of planning	16
	Concentration close to the resources of water	5
	Over-grazing	7
	Governmental support	5
	Increasing of Bedouin movement	3
	Wood-cutting	17
	Weakness of traditional <i>hema</i> system	18

Conclusion

Based on the results of this study, the highlands of the Asir region have been divided into two distinct grazing zones, namely, the mountainous grazing zone and plateau grazing zone. The first zone extends along the west and the south-west of the research area, and is characterised by a low level of grazing. The second zone covers a wide area in the north-eastern portion of the research area, and is characterised by intensive grazing.

(2) The government has funded Bedouins to buy tankers and dig wells during the last two decades.

The effect of overgrazing on the vegetation of the research area is manifested in the disappearance of the species preferred by animals, such as **Commicarpus grandiflous**, **Periploca aphylla**, **Cymbopogon schoenanthus**, **Hyperhenia hirta** and **Rumec vesicurius** (Hajar, 1993), and the presence of the less palatable species such as **Psiadia arabica**, **Euryops arabicus**, **Lavandula dentata**, **Solanum incanum** and **Solanum schimperianum**, as well as the deterioration in quality of plants, e.g. **Acacia arabica** in the north-eastern part of the research area. Also, this effect extends to the soil, particularly in the plateau zone, where the soil is coarse and poor in nutrients.

For the conservation and protection of soil and natural vegetation as well as the potential use of Asir highlands, the following recommendations are offered:

- 1 - The successful method of conservation (the *hema* system) that was adopted over a very long period of time by the tribes in the Al-Hejaz region to protect the trees, shrubs and pastures should be reapplied, with some modifications to be appropriate to the present time (e.g. cancellation of tribal quality). This system should be carried out under supervision of the Ministry of Agriculture and Water and with the cooperation of the Ministry of Interior.
- 2 - Reforestation and planting of trees and shrubs that are well adapted to the environmental conditions of Asir highlands, such as **Tamarix aphylla**, **Olea europaea** and **Acacia negrii** should be encouraged.
- 3 - Cutting green trees and shrubs should be prevented completely by enforcement of laws prohibiting it. Alternative sources of fuel (e.g. Gas) should be provided by the Government in the markets. If no alternatives are available, the inhabitants of the Wadi Bishah basin will be forced to obtain fuel from **Acacia arabica**, **Acacia gerradii**, **Acacia negrii** and **Juniperus procera**.
- 4 - Grazing should be prohibited in the research area, at least for a

limited period (e.g. three months after rainfall period), and the numbers of livestock should be reduced, particularly in the north-east of Wadi Bishah basin. This would allow the vegetation cover to recover from the intense overgrazing and trampling by animals.

- 5 - The Bedouin should be encouraged to replace traditional grazing methods with specialized grazing methods, such as fattening methods which can be based largely on modern technology.

Finally, these findings correspond with those of several other research works conducted in desert and semi-desert areas. For instance, in the Mediterranean desert of Egypt, and in Southern Tunisia, density, relative covering value frequency and presence of perennial species were found to increase as a result of reduction of livestock and control of grazing (Ayyad & El-Kadi, 1982; Floret, 1981).

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