

**Influence of Excluding Grazing on Vegetation Attributes at the Eastern Slopes of West Bank**

أثر منع الرعي على الخصائص الطبيعية للنباتات في السفوح الشرقية من الضفة الغربية

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**Abstract**

The influence of excluding grazing on range vegetation attributes was studied at the Eastern Slopes of West Bank. Vegetation attributes were compared at a grazed plot and an ungrazed plot in the years 2004 and 2005. Results showed that plant density in the excluding grazing area was (518.9 Plants m<sup>-2</sup>) higher (p <0.05) than that in grazed plot (194.4 plants m<sup>-2</sup>) in the year 2005. In addition, total plant cover averaged 94% and 93% in ungrazed plots while 54% and 68% in grazed plots during the years 2004 and 2005 respectively. By April, 70% of plant biomass was already utilized by grazing ruminants, and subsequently induced change in the botanical composition by increasing unpalatable species like: *Sarcopoterium spinosum*, *Asphodelus aestivus*, *Echinops polyceras*, and *Eryngium creticum* in grazed plot. At the ungrazed plot, palatable species such as *Medicago spp*, *Bromus spp*, *Hordeum spp*, *Aegilops spp*, *Poa bulbosa* and *Avena sterilis* were dominant. In addition, vegetation in the ungrazed plot was more diverse than in the grazed plot, moreover, excluding grazing increased species richness by 57 %. Results indicated that overgrazing induced vegetation retrogression and reduced the length of the grazing period for two months only. In conclusion, selection of

suitable grazing management, mainly grazing time and stocking rate, at rangelands in Southern West Bank is an urgent practice that should be implemented to stop the vegetation retrogression trend of these rangelands

**Key words:** Rangelands, vegetation attributes, dry plant biomass, grazing management, species richness

### ملخص

في تجربة حقلية نفذت بين عامي ٢٠٠٤ و ٢٠٠٥ تمت دراسة أثر منع الرعي على الخصائص الطبيعية للنباتات الرعوية في منطقة السفوح الشرقية جنوب الضفة الغربية. وقرنت الدراسة الخصائص الطبيعية في منطقة مُنَع الرعي فيها مدة تسع سنوات، مع منطقة مفتوحة الرعي بصورة جائرة. وأظهرت النتائج أن كثافة النباتات في المنطقة التي منع فيها الرعي بلغت (٥١٨.٩ نبتة / م<sup>٢</sup>)، فكانت أعلى من المنطقة مفتوحة الرعي حيث بلغت (١٩٤.٤ نبتة / م<sup>٢</sup>)، في العام ٢٠٠٥. وتشير النتائج إلى أن نسبة الغطاء النباتي قد انخفضت من ٩٤% و ٩٣% في المنطقة التي منع فيها الرعي إلى ٥٤% و ٦٤% في المناطق مفتوحة الرعي خلال العامين ٢٠٠٤ و ٢٠٠٥ بالترتيب. وبينت الدراسة أن الحيوانات المُجترّة استهلكت حوالي ٧٠% من المادة الجافة للنباتات بحلول شهر نيسان في المناطق مفتوحة الرعي، وهذا أدى إلى تغيير في الأنواع النباتية الموجودة حيث زادت النباتات غير المرغوبة رعوياً مثل: نبات التنتش (*Sarcopoterium spinosum*) والغيصلان (*Asphodelus aestivus*) وشوكة الجمل (*Echinops polyceras*) والقرصنة (*Eryngium creticum*) بينما في المناطق محمية الرعي زادت نسبة النباتات الرعوية. وبينت الدراسة أيضاً أن تعدد الأنواع النباتية في المناطق التي منع الرعي فيها قد زاد عن المناطق مفتوحة الرعي. تشير النتائج أيضاً إلى أن الرعي الجائر والمفتوح أحدث تغييراً نحو تدهور المراعي وقلل من فترة الرعي إلى شهرين فقط في السنة. لذلك من أجل وقف تدهور المراعي في جنوبي الضفة الغربية فمن المهم اختيار طرق تنظيم الرعي ولاسيما في موعد فتح المراعي وكثافة الرعي.

### Introduction

Understanding and quantifying the effect of grazing on the vegetation community is important for management and conservation of rangelands (Noy-Meir et al, 1989, pp: 290-310. Sternberg et al, 2000, pp: 224-237). Therefore, many researchers have studied the effect of grazing on range vegetation. Beeskow et al (1995, pp: 517-522), investigated the effect of grazing intensity on rangeland in Southern Argentina, and concluded that the most important change recorded was the

transformation of the grass steppe into shrub steppe. They also found that the size of bare patches was increased, leading to an accelerated erosion process. These results agreed with Pantis and Mardiris (1992, pp: 232-242), who found that grazing increased the cover of undesirable species from 7 % to 50 %, and the total plant cover decreased from 80 % to 4 %. According to Holechek et al (1989, p.173), the selection of the correct stocking rate is the most important grazing management. Le-Houerou (1993, p.179) reported that heavy grazing decreased the number, density and cover of palatable species.

As in other Mediterranean rangelands, Palestinian rangelands have been grazed by domestic livestock, mainly sheep and goats for at least 5000 years (Noy- Meir and Seligman, 1979, p.134. Pearse, 1970, pp: 13-16).

Most of rangelands in West Bank were open to farmer before Israeli occupation. After 1967, military restrictions have reduced the total area available for grazing (ARIJ, 1994, P.130). Farmers usually start grazing when certain plants begin to appear on rangelands, and the termination of grazing depends largely on the depletion of palatable plants and lack of drinking water (Abu-Zant et al, 2003 pp:5-6). In a survey conducted by ARIJ (1994, pp: 132-134), it was clear that natural pastures in the West Bank include several important fields, such as Al-Baai'a region, Arab Al-Ta'amreh region, Arab Al-Ka'abneh region, arab Al-Rashayda, Wadi Al-Juhhar, and Wadi Sa'ir.

With the increase of the population in West Bank, the demand for animal products has grown, and subsequently the number of livestock increased (PCBS, 2003, pp: 34-42). This increase in livestock is associated with a decrease in the available rangelands, due to military restrictions and expansion of urban area and cultivated lands. As a result, rangelands resources are being put under a serious pressure of early and overgrazing, which has led to decrease in vegetation cover and productivity; increase in poisonous and unpalatable plants; severe soil erosion and ultimately to the threat of desertification in many areas (Al-Seikh, 2006, p.85. Mohammad, 2005, pp: 42-54)



(unpublished). Plants were identified according to Al- Eisawi, 1998. Zohary, 1966. Burnie, 1995 and Ori et al, 1999.

Vegetation cover and plant biomass were evaluated as follows:

### ***Plant Dry Biomass***

At each treatment (grazed and ungrazed plots) fifteen 1 m<sup>2</sup> quadrat (square plots) were randomly allocated (as replicate), and all the current year growth of each plant species inside the quadrat was clipped to the soil surface and placed in labeled paper bags except for rare species which placed in one bag for each quadrat. Fresh and dry weights (65 C°) were recorded (Bonham, 1989, p.201). A completely randomized design was used to compare between the treatments.

### ***Plant Density***

At each treatment fifteen 0.25 m<sup>2</sup> square quadrat were randomly allocated (as replicate). The number of all species and individual number of each species were recorded for each quadrat (Bonham, 1989, p.141).

### ***Vegetation Cover***

To measure the ground cover percentage at each plot, a one hundred point step method (Evans and Love, 1957, pp:208-113) was used at each treatment to record whatever appeared below the tip of the boot along a randomly laid transect (soil, rock, or plant by species), then the percentages of soil, rock, and plant were calculated.

### ***Species Richness and Diversity***

Species richness (s) is the number of species in certain area within a community (Barbour et al, 1987, p.162). Richness was calculated as the number of species in an area (15quadrats \* 0.25 area of each quadrat), regardless of their density.

The Shannon-Weiner index was used as diversity index. The Shannon-Weiner index assumes that individuals were sampled from a very large population and that all species are represented in the sample. It was estimated as follows:

$$H' = - \sum_{i=1}^S (p_i \ln p_i)$$

Where  $s$  is the number of species,  $P_i$  is the proportion of individuals found in the  $i$ th species (Gurevitch et al, 2002, p. 244 ).

### **Statistical Analysis**

Biomass and plant density were analyzed by using Sigma Stat 2.0 for Windows<sup>®</sup> program.

## **Results**

### **Plant Biomass**

Data showed a significant ( $p < 0.05$ ) amount of plant dry biomass was removed by livestock grazing in grazed compared to ungrazed plots during both years 2004 and 2005 (Table 1). It was found that plant dry biomass in grazed plot was 313.7 kg ha<sup>-1</sup> and 559.7 kg ha<sup>-1</sup> during the years 2004 and 2005 respectively, while in ungrazed plot it was 978.5 kg ha<sup>-1</sup> and 2104.8 kg ha<sup>-1</sup> during the years 2004 and 2005, respectively (Table 1). Comparing to the ungrazed plot, data showed that livestock utilized about 70 % of the dry biomass, despite the fact that vegetation measurements were carried out in April.

**Table (1):** Average plant dry biomass (kg m<sup>-2</sup>) in grazed and ungrazed plots at the study site in 2004 and 2005.

<b>Year</b>	<b>2004</b>	<b>2005</b>
Ungrazed	978.5* ±232.7 a**	2104.8 ±350.3 a
Grazed	313.7±116.3 b	559.7±135.6 b

\*\* Means followed by the same letters within the same column are not significantly different according to Fisher LSD Method at  $P \leq 0.05$ .

\* Mean of fifteen replicates ±SE.

During the year 2005, Shrubs have the highest dry biomass (301.3 kg ha<sup>-1</sup>) in the grazed plot; despite that only two shrub species were dominant. The unpalatable semi-shrub *Sarcopoterium spinosum* has the highest dry biomass; (245 kg ha<sup>-1</sup>) followed by *Thymelaea hirsute* that has dry biomass equal to 56.3 kg ha<sup>-1</sup>. Total forbs dry biomass in the grazed plot was 166.1 kg ha<sup>-1</sup> and varied among species. *Asphodelus aestivus* has the highest dry biomass (93.1 kg ha<sup>-1</sup>). In the ungrazed plot; forbs has the highest plant dry biomass (1427.4 kg ha<sup>-1</sup>), and *Asphodelus aestivus* (306.2 kg ha<sup>-1</sup>) was the dominant forb followed by *Anthemis palaestina* (186.3 kg ha<sup>-1</sup>) and *Ballota undulate* (169.4 kg ha<sup>-1</sup>) (Table 2). Grasses dry biomass was 445.3 kg ha<sup>-1</sup> in 2005 with *Poa bulbosa* has the highest dry biomass (312.9 kg ha<sup>-1</sup>).

**Table (2):** Average plant dry biomass (kg ha<sup>-1</sup>) for each species at the study site in grazed plots compared with ungrazed plots during the years 2004 and 2005.

Plant Species	Ungrazed		Grazed	
	2004	2005	2004	2005
<b>Grasses</b>				
<i>Avena sterilis</i>	0	2.9	0	0
<i>Bromus fasciculatus</i>	0	0	0	5.5
<i>Bromu spp</i>	7	25.1	0	0
<i>Crithopsis delileana</i>	0	0	0	4.7
<i>Hordeum spontaneum</i>	0	0	0.9	0
<i>Lolium sp</i>	0	0	1.5	4.4
<i>Phalaris sp</i>	5.5	20.1	2.9	31.2
<i>Piptatherum miliaceum</i>	0	42.3	0	0
<i>Poa bulbosa</i>	161.7	312.9	4.6	41
<i>Stipa capensis</i>	16.8	42	4.9	3.3
Other grasses	0.7	0	0	2.1
<b>Total Grasses</b>	<b>191.7</b>	<b>445.3</b>	<b>14.8</b>	<b>92.2</b>





... Continue table (2)

Plant Species	Ungrazed		Grazed	
	2004	2005	2004	2005
<b>Grasses</b>				
<i>Medicago sp</i>	8.1	41.1	0	0
<i>Minuartia decipiens</i>	0	0	0	0
<i>Notobasis syriaca</i>	4.1	10.3	0	0
<i>Ononis sicula</i>	0	31.7	0	0
<i>Ononis sp</i>	0	11.5	0	0
<i>Onobrychis caput-galli</i>	2.5	61.8	0	0
<i>Onopordon alexandrium</i>	28.7	0	0	
<i>Pallenis spinosa</i>	0	27.6	0	0
<i>Plantago afra</i>	0	0	0	1.8
<i>Salvia palestinea</i>	0	55.6	0	0
<i>Scorzonera schweinfurthii</i>	7	0	0	0
<i>Sinapis arvensis</i>	2.5	0	0	0
<i>Sonchus oleraceus</i>	0	2.9	0	0
<i>Tragopogon porrifolius</i>	1.7	6.8	0	0
<i>Trigonella stellata</i>	0	8.3	0	0
<i>Trifolium stellatum</i>	1.8	7.1	0	0
<i>Trifolium spp</i>	0	0.3	0	0
<i>Torilis tenella</i>	10.6	7.4	0	0
<i>Urginea maritima</i>	0.5	0	3.4	5.3
<i>Vicia sp</i>	0	11.3	0	0
Other forbs	21	132.3	3.6	8.9
<b>Total Forbs</b>	<b>361.2</b>	<b>1427.4</b>	<b>187.8</b>	<b>166.1</b>
<b>Shrubs</b>				
<i>Astragalus spinosus</i>	82.8	0	0	0
<i>Phagnalon rupestre</i>	0	9.3	0	0
<i>Sarcopoterium spinosum</i>	0	143.2	61.1	245
<i>Scrophularia xanthoglossa</i>	122	49.1	0	0
<i>Thymelaea hirsute</i>	220.8	30.5	50.1	56.3
<b>Total Shrubs</b>	<b>425.6</b>	<b>232.1</b>	<b>111.2</b>	<b>301.3</b>



... Continue table (3)

Items	ungrazed		Grazed	
	2004	2005	2004	2005
<i>Carlina hispanica</i>	1	1	0	0
<i>Carthamus tenuis</i>	0	0	0	3
<i>Centaurea sp</i>	1	3	1	1
<i>Cichorium pumilum</i>	0	2	2	6
<i>Crepis aspera</i>	1	5	0	2
<i>Crithopsis delileana</i>	0	0	0	1
<i>Echinops polyceras</i>	4	4	2	8
<i>Erodiun acaule</i>	0	1	0	0
<i>Erodium gruinum</i>	9	11	0	0
<i>Euphorbia sp</i>	0	0	0	1
<i>Eryngium creticum</i>	1	2	4	3
<i>Eryngium sp</i>	3	1	0	0
<i>Gundelia tournefortii</i>	0	2	1	0
<i>Helianthemum salicifolium</i>	1	0	0	0
<i>Heliotropium europoeum</i>	1	1	0	0
<i>Lactuca orientalis</i>	1	1	0	0
<i>Lomelosia palaestina</i>	7	4	0	0
<i>Lolium sp</i>	0	0	0	1
<i>Malabaila secaul</i>	0	1	0	1
<i>Medicago sp</i>	3	0	0	0
<i>Notobasis syriaca</i>	3	1	0	0
<i>Ononis sp</i>	0	2	0	0
<i>Onobrychis caput-galli</i>	2	3	0	1
<i>Salvia sp</i>	3	0	0	1
<i>Tetragonolobus palaestinus</i>	1	0	0	0
<i>Tragopogon porrifolius</i>	2	1	0	0
<i>Trigonella stellata</i>	0	1	0	2
<i>Trifolium campestre</i>	0	1	0	0
<i>Trifolium resupinatum</i>	0	2	0	0



**Table (4):** Average plant density (plants m<sup>-2</sup>) in grazed and ungrazed plots at the study site during the years 2004 and 2005.

Year	2004	2005
ungrazed	645.9* ±127.2 a**	518.9 ±85.6 a
Grazed	103.2 ±25.6 b	194.4 ±20.6 b

\*\* Means followed by the same letters within the same column are not significantly different according to Fisher LSD Method at  $P \leq 0.05$ .

\* Mean of fifteen replicates ±SE.

By taking the plant density of grasses, forbs and shrubs in the year 2005, data showed that excluded grazing increased grass density (144.6 plants m<sup>-2</sup> in the grazed plot versus 316.7 plants m<sup>-2</sup> in the ungrazed plot); while total shrubs density nearly were not changed (Table 5).

Plant density of some species was increased at the grazed plot compared to the ungrazed plot. Among these species were: *Sarcopoterium spinosum*, *Asphodelus aestivus*, *Lolium sp*, *Cichorium pumilum*, *Eryngium creticum*, *Trigonella stallatum*, *Evax contracta*, *Hordeum spontaneum*, and *Plantago afra* (Table 5). On the other hand, other species were increased in the ungrazed plot such as: *Avena sterilis*, *Poa bulbosa*, *Bromus tectorum*, *Anthemis palaestina*, *Biscutella didyma*, *Trifolium stellata*, *Helianthemum salicifolium*, *Onobrychis caput-galli*, *Ononis sicula*, *Anagallis arvensis* and *Atractylis cancellata* (Table 5), all these species are annual except *Poa bulbosa*.

**Table (5):** Average plant density (plants m<sup>-2</sup>) for each species at the study Site in grazing plots compared with ungrazed plots during the years 2004 and 2005

Plant Species	Ungrazed		Grazed	
	2004	2005	2004	2005
<b>Grasses</b>				
<i>Aeglibose spp</i>	0	0	0	0.8
<i>Avena sterilis</i>	0	0.8	0	0.3
<i>Bromus fasciculatus</i>	0	1.1	0	5.9
<i>Bromus lanceolatus</i>	0	0.3	0	0
<i>Bromuse tectorum</i>	0	0.5	0	0
<i>Bromu sp</i>	12.5	1.9	0	1.1
<i>Crithopsis delileana</i>	0	0.3	0	5.3
<i>Hordeum spontaneum</i>	0	0	2.1	0.3
<i>Lolium sp</i>	0	0	10.1	8.5
<i>Phalaris sp</i>	27.2	54.7	20.3	44.3
<i>Piptatherum miliaceum</i>	0	0.3	0	0
<i>Poa bulbosa</i>	408	247.7	22.7	75.7
<i>Stipa capensis</i>	41.3	9.1	23.2	2.4
<b>Total Grasses</b>	<b>489</b>	<b>316.7</b>	<b>78.4</b>	<b>144.6</b>
<b>Forbs</b>				
<i>Allium stamineum</i>	0.3	0.3	0	0
<i>Anagallis arvensis</i>	3.7	7.2	0.3	0.3
<i>Anthemis palaestina</i>	49.9	76.5	0	0
<i>Arnebia tinctoria</i>	0.3	0	0	0
<i>Asphodelus aestivus</i>	2.1	5.1	6.7	3.7
<i>Atractylis cancellata</i>	1.6	6.4	0	0.5
<i>Ballota undulate</i>	0	0.3	0	0
<i>Biscutella didyma</i>	1.1	1.1	0	0.3

... Continue table (5)

Plant Species	Ungrazed		Grazed	
	2004	2005	2004	2005
<i>Grasses</i>				
<i>Carlina curetum</i>	0	0	0.3	0
<i>Carlina hispanica</i>	0	0.5	0	0
<i>Carthamus tenuis</i>	0.5	2.7	0	1.3
<i>Centaurea sp</i>	1.3	1.3	0	0
<i>Cerastium inflatum</i>	0	0	0	1.9
<i>Cichorium pumilum</i>	0.5	1.1	1.1	3.7
<i>Crepis aspera</i>	0	4	0	2.9
<i>Echinops polyceras</i>	0.5	1.1	1.1	0.5
<i>Erodiun acaule</i>	0	0.3	0	0
<i>Erodium gruinum</i>	13.3	12.5	0	0
<i>Eryngium creticum</i>	0	0	1.3	1.1
<i>Euphorbia paralias</i>	0	1.9	0	0
<i>Euphorbia sp</i>	0	0.3	0	0
<i>Evax contracta</i>	1.9	0	11.7	6.7
<i>Gundelia tournefortii</i>	0	0.8	0	0
<i>Gynandrisis sisyrinchium</i>	0	0.5	0	0.3
<i>Hedypnois cretica</i>	0	0.3	0	0.3
<i>Helianthemum salicifolium</i>	0	14.7	0	0.8
<i>Lactuca spp</i>	0.8	0	0	0
<i>Lagoecia cuminoides</i>	0	0.3	0	0.3
<i>Lathyrus cicera</i>	13.9	0.5	0	0
<i>Lomelosia palaestina</i>	13.6	13.9	0.5	0
<i>Malabaila secaul</i>	6.9	1.3	0	0
<i>Medicago sp</i>	1.9	5.9	0.3	0





... Continue table (5)

Plant Species	Ungrazed		Grazed	
	2004	2005	2004	2005
<b>Grasses</b>				
<b>Shrubs</b>				
<i>Astragalus spinosus</i>	0.3	0	0	0
<i>Sarcopoterium spinosum</i>	0	0.3	0.3	1.6
<i>Scrophularia xanthoglossa</i>	0.5	0.3	0	0
<i>Thymelaea hirsute</i>	0.3	0	0.5	0
<b>Total Shrubs</b>	<b>1.1</b>	<b>0.6</b>	<b>0.8</b>	<b>1.6</b>

It was noticed that in the grazed plots the highly palatable species (Ice cream plants) were utilized early in grazing season, therefore, they were only found in the ungrazed plot, among these species are: *Elymus sp*, *medicago spp*, *Erodium gruinum* and *Vicia sp*.

### ***Plant Diversity***

Grazing decreased the species richness. Plant species richness at the grazed plot was 35 species per 3.75 m<sup>2</sup>, whereas it was 54 species per 3.75 m<sup>2</sup> at the ungrazed plot in the year 2005. Using Shannon-Weiner index, it was found that ungrazed plot was more diverse (1.2) than grazed plot (0.95) in the year 2005.

### **Discussion**

#### ***Plant Biomass***

Data in table (1) showed that there was lack of correlation between precipitation and plant dry biomass during the years 2004 and 2005. This might be due to variation in the climatic factors specially the amount and the distribution of rainfall. Similar results were observed by Mohammad (2000, pp: 75-87) at Southern part of the West Bank, who concluded that the distribution of the precipitation in growing season and soil characteristics determine range land productivity.



and economically sustainable grazing management practice for domestic livestock on rangelands. This is consistent with Le-Houerou (1993, p. 192) who concluded that reduced intensity of grazing offers the only practical means of range improvement in Mediterranean rangelands. Therefore further researches are highly needed to investigate the suitable grazing management in the West Bank rangeland.

### ***Plant Density***

The study site was subjected to early and heavy grazing; where the plants have no chance to grow or reproduce. Therefore, the decrease in plant density at grazed plots and the increase in plant density, mainly the annuals, at excluding grazing plots might be due to either the consumption of plants by livestock, or the damage of small plants by trampling. Such factors depend on grazing period and grazing intensity (Holechek et al, 1989, pp: 115-118).

The other possibility could be due to the effect of livestock on the seed bank because livestock graze vegetation in spring when most of the plant species are flowering or producing seeds; since annuals need to set seed year after year to maintain themselves. Seed banks in the Mediterranean grasslands following a long period of uncontrolled grazing were studied by Abu-Zanat et al (1998, pp: 195-202), and they found that the number of plant species in the soil seed banks was low. This agrees with Al-Shawahneh et al (1998, pp:380-391) who concluded that uncontrolled grazing of rangelands had a negative impact on the seed production and seed survival of the existing plants which results in a very small size of seed banks.

The presence of palatable species with moderate density in grazing plots might be due to their defense strategy as these species seem to be adapted to resist grazing. Stremberg et al (2000, pp:224-237) concluded that hemicryptophytic species such as *Hordeum bulbosum* were adapted to survive under heavy and very heavy grazing pressure, as their perennating buds are buried near the soil surface and most of their shoots desiccate in summer. On the other hand, it was noticed that some of the palatable species were hidden under unpalatable shrubs as *Sarcopoterium*



to forbs to re-grow. Secondly, due to their reproduction methods as forbs depend mainly on producing large number of seeds. Livestock graze vegetation in spring when most of the plant species are flowering or producing seeds; grasses largely reproduce by buds and rhizomes that are buried under soil surface and re-grow when grazing is excluded.

The disappearance of some shrubs in grazed plot, might be due to the random sampling method that was used, as in this method, the location of the transect different each year, and the very rare species might not appear or recorded.

### **Conclusion**

Under present conditions; early and severe overgrazing induced vegetation retrogression that is expressed in decreasing plant density, and biomass and an increase in unpalatable plant species, thus reducing the length of grazing period for about two months only. Therefore, to have clear picture of response of species to grazing and protection at the West Bank rangelands, long-term studies are necessary to understand species persistence in these rangelands. These studies will be useful in future management recommendations for conservation and sustainable development for livestock production. And further studies are needed to investigate the suitable grazing management in these areas.

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### **References**

- Abu-Zanat, M. Ahmed, A. Shadi, H. Salah, L. & Bassam, M. (2003). "Promoting agro biodiversity conservation in rangeland of the dry area". Seven International conferences on Development of Dry lands. Tahrán. Iran.

- Abu-Zanat, M. Osman, A. Tabba'a, M. (1998). "Seed bank assessment on heavily grazed Mediterranean grasslands in Jordan". Dirasat, Agricultural Science. (25). 195-202.
- Al-Eisawi, D. (1998). Field guide to wild flowers of Jordan and neighboring Countries. Daud al-Eisawi. Amman. Jordan.
- Al-Seikh, S. (2006). "The influence of different water harvesting techniques on soil properties and their role to reduce soil erosion and sedimentation". Unpublished M.Sc thesis, College of Graduate Studies & Academic Research. Hebron University. Palestine.
- Al-Shawahneh, N. Kafawin, O. Abu-Zanat, M. & Hadidi, N.(1998). "Effect of landuse on the seed banks of rangeland soil in arid environments". Dirasat, Agricultural Science. (25). 380-391.
- Applied Research Institue –Jerusalem (ARIJ). (1994). Dryland farming in Palestine. Palestine.
- Applied Research Institue –Jerusalem (ARIJ). (1997). The Status of Environment in the West Bank. Palestine. Jerusalem.
- Barbour, M. Burk, J. & Pitts, W. (1987). Terrestrial plant ecology. 2<sup>nd</sup> ed. The Benjamin/Cummings Publishing Company, Inc. California.
- Beeskow, A. Elissalde, N. & Rostagno, C. (1995). "Ecosystem changes associated with grazing intensity on the Punta Ninfas rangelands of Patagonia, Argentina". Journal of Range Management. (48). 517-522.
- Bonham, C. (1989). Measurement for Terrestrial vegetation. John Wiley & Sons, Inc. USA.
- Burnie, D. (1995). Wild Flower of the Mediterranean. Dorling Kindersley Hand Book. London.
- Evans, A. & Love, R. (1957). "The step-Point method of sampling . A practical tool in range research". Journal of Range Management. (10). 208-213.
- Geographic Information System Unit (GIS). (2004). Hebron University. Data base.
- Gurevitch, J. Scheiner, S. & Fox, G. (2002). The Ecology of Plant. Sinauer Associates, Inc, Publishers. Massachusetts U.S.A.

- Gutman, M. & Seligman, N. (1979). "Grazing management of Mediterranean Foot-hill range in the upper Jordan River Valley". Journal of Range Management. (32). 86-92.
- Holechek, J. pieper, R. & Herbel, C. (1989). Range Management Principles and Practices. 2<sup>nd</sup> ed. Prentice Hall, Englewood Cliffs, New Jersey.
- Le Houerou, H. (1993). "Grazing lands of the Mediterranean Basin". In: "Couplands, R. Natural grasslands, Eastern hemisphere ecosystems of the world". (18). Elsevier Scientific Published. Amsterdam, the Netherlands.
- Le Houerou, H. & Host, C. (1977). "Rangeland production and annual rainfall relation in the Mediterranean Basin and in the African Sahelo- sudanian Zone". Journal of Range Management. (30). 181-189.
- Mazancourt, C. (1998). "Grazing optimization and nutrient cycle: when do herbivores enhance plant productive". Ecology ([www.findarticles.com](http://www.findarticles.com)). (abstract).
- Mazancourt, C. & Loreau, M. (2000). "Grazing optimization, nutrient cycling, and spatial heterogeneity of plant- herbivore interactions: should a palatable plant". evolve. Evolution. (54). 81-92.
- Mc-Naughton, S.(1979). "Grazing as an optimization process: grassungulate relationships in the Serengeti". American Naturalist. (113). 691-703.
- Ministry of Agriculture (MOA). (2004). Rainfall data base. Annual rainfall data.
- Mohammad, A. (2000). "Vegetation cover and productivity of the rangeland in the Southern part of West Bank". Bethlehem University Journal. (19). 75- 87.
- Mohammad, A. (2005). "Rangeland condition at southern West Bank". Hebron University Research Journal. (2). 42-54.
- Mohammad, A. (2007). "Growth and development of range plants at southern West Bank". Hebron University research Journal. (accepted for publication).

