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FEEDING COST REDUCTION OF AWASSI SHEEP THROUGH RANGELAND REHABILITATION AT KHANASRI IN THE NORTHERN BADIA OF JORDAN

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ABSTRACT

The present study was conducted at Khanasri during 2012, 2013 and 2014 and aimed to determine the effect of rangeland rehabilitation on feed cost, rangeland productivity, and stocking rate. Three rangeland systems were included in this study: Fodder shrubs, native vegetation and open access. Year 2012 native vegetation fresh yield had significance differences. The fodder shrubs allowable yield was 138.4, 51.2 and 92.5 kg ha^{-1} for 2012, 2013 and 2014 years, respectively. The interaction between treatments fodder shrubs and native vegetation systems and year 2012 showed high significance yield while open access with all years showed the lowest yield. The interaction between treatments fodder shrubs and native vegetation systems and year 2012 showed high significance total dry, allowable, site yield and stocking rate while open access with all years showed the lowest yield values. The fodder shrubs and native vegetation systems were decreased feeding cost. The year 2012 was more effective or profitable in comparison with the results of 2013 and 2014 due to rainfall amounts. We concluded that both fodder shrubs and native vegetation systems were increased rangeland productivity, stocking rate and decreasing sheep feeding cost.

KEYWORDS: Feeding Cost, Jordan, Native Vegetation, Rangeland, and Sheep

INTRODUCTION

In Jordan, livestock population numbers has increased from 2.133 million in 1979 to 6.533 million in 2013 [1]. Moreover, the sheep and goat numbers in Jordan were 3.147.600 head in 2013 [1]. Consequently, their demand for meat is increasing. Local feed resources such as barley, brain and straw are limited, thus there is a large gap between available resources and livestock requirements. Jordan produces 20%-25% of feedstuff requirements, rangeland produce 80% of those requirements [2]. Rangeland form about 90% of the total land area in Jordan which is 89.342 km^2 and receives less than 200 mm annual rainfall [1, 2]. It was subjected to severe degradation due to successive drought and man misuse. Man misuse is practiced through cultivation for barley planting, early and overgrazing, shrubs cutting for fuel using and introducing heavy vehicles, especially the tractor to rangeland [3].

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Therefore, indigenous resources need to be protected and developed [4]. There are several solutions to provide feed mainly import, green fodder cultivation, cultivation of field crops such as barley and vetch, and rehabilitation of rangeland region through protection and planting fodder shrubs using water harvesting system. Le Houerou reported that rehabilitation of the degraded rangeland will be by protection, fodder shrubs planting and water harvesting techniques [5]. For restoration of rangeland feed resources, technical options are needed. One of these is re-establishment and use of native and exotic fodder shrubs such as saltbushes (*Atriplex* spp.). Fodder shrubs play a role in rangeland rehabilitation programs in arid and semi-arid Mediterranean zone, not only as a feed reserve but also for soil water conservation in the degraded regions [6]. They have a vital role in improving extreme climatic effects, gully erosion control and providing stock feed [7]. *Atriplex halimus* is the most planted native species in Syria, Jordan, Egypt, Saudi Arabia, Libya and Tunisia. In addition to their drought and salinity tolerance, *Atriplex* have high yield, good nutritive value [8] and palatability to sheep in non-saline soils [9]. Also, Abu-Irmaileh showed that rangeland improving by planting fodder shrubs under water harvesting produced much more forage than those obtained by protection alone [10]. The present study showed the role of rangeland rehabilitation to satisfy sheep feed requirements. In Jordan the forage costs are very high and farmer's income is very low due to the little margin profit. Animal feed input prices increased dramatically in West Asia and North Africa region (WANA), those increases have a major effect on livestock producers [11]. One half or more of the sheep, goats, and cows diets are based on concentrates to be bought by farmers [12]. The price increases affect all producers, especially small farmers and herders who are affected more seriously than others. It is believed that the nomads or transhumant households are suffering more than farmers in high-rainfall areas. The nomads do not have adequate chances to change their living style and do not have any other options to increase their own feed production [13].The local production of feed stuffs cover only 25% of the feed requirements; while the other 75% of feed is covered by importing feed. This increases the total feed cost of livestock represents 75% of the total cost of livestock production [14]. Thus, protected rangeland (native vegetation) and planted fodder shrubs in comparison with open rangeland were selected in this study. The study objectives are to determine the effect of rangeland rehabilitation on feed cost, rangeland productivity, and stocking rate.

MATERIALS AND METHODS

The present study has been carried out at Khanasri Range Reserve which is located in Mafraq District and far about 80 km to the northern east of Amman (latitude 32^o 24' N, longitude 36^o 03' E and altitude of 668 m above sea level). The topography of this reserve characterized by formation of hills with slope fluctuated between 2-10%. The average annual rainfall is 150 mm. The total area of the reserve is 450 ha, about 100 ha of which were planted by fodder shrubs A. halimus.

A total area of 200 ha was included in the present study. One hundred hectare of the area was planted by fodder shrubs while; the area of native vegetation was 100 ha. *Atriplex* shrubs were planted on 2008 using water harvesting techniques named contour ridges (CR). The average spacing between CR was 8 m while between shrubs 3 m. The plant density was 417 shrubs per hectare. Data were recorded for 3 years 2011/2012, 2012/2013 and 2013/2014. Yield of both *A. halimus* shrubs and native vegetation were measured on May 2012, 2013 and 2014.

Treatments

Three rangeland systems were included in this study namely; (1) fodder shrubs (including yield of both *A. halimus* shrubs and native vegetation cover), (2) native vegetation, and (3).open access (site adjoining to Khanasri Station and subjected to overgrazing).

Fodder Shrubs (FS)

A. halimus shrubs yield was measured using Reference Unit Method [15]. Recording size of sample shrubs was detected according to a selected branch of A. halimus shrubs. Fifty shrubs were randomly selected within each treatment and the following measurements were taken: fodder shrubs fresh yield (FSFY) shrub growth weight of above ground, fodder shrubs browse yield (FSBY) shrub leaves and twigs less than 5 mm thin weight and fodder shrubs dry yield (FSDY) FSBY weight after drying at 72 $^{\circ}$C for 72 h. Fodder shrubs allowable yield (FSAY) was calculated as a 60 % of FSDY.

Native Vegetation (NV)

It was measured using clipping method (it is the most common direct method to estimate native vegetation biomass production [16]). Six transects of 50 m long were selected randomly for open and protected treatments, each transect contained 5 quadrates of 0.5 m^2. A total of 15 quadrates were clipped for each treatment and the following measurements were taken: native vegetation fresh yield (NVFY) annual vegetation growth weight of above ground, native vegetation dry yield (NVDY) weight after drying at 72^0C for 72 h. Native vegetation allowable yield (NVAY) was calculated as a 60 % of NVDY.

Total Yield

It was calculated by sum fodder shrubs and native vegetation fresh, dry and allowable yield for ha then calculated for site (Yield (kg/ha) * Area (ha)).

Animal Feed

The number of sheep was 484, 410 and 464 head for 2011/2012, 2012/2013 and 2013/2014 growing seasons, respectively. The average daily intake at Khanasri was 0.670 kg barley and 0.086 kg wheat bran per head. While, straw is available all the time and its consumption estimated by 30% of barley consumption (about 0.201 kg $head^{-1}$ day). The local prices of barley, wheat bran and straw were 210, 100 and 180 JD ton^{-1}, respectively. The currency unit was 1 US$ = 0.708 Jordanian Dinar (JD) during the present study period.

Stocking Rate

It is defined as the number of grazing sheep during certain period. In this study it was calculated as the number of sheep and grazing period in addition to complementary feed (includes barley, bran and straw) dependent on yearly rangeland yield. The grazing period was 180 day started on May and ended on August. The complementary feed from the rangeland area was 1.200, 1.314 and 1.253 kg $head^{-1}day^{-1}$ based on 2 kg dry matter head requirement per day for 2011/2012, 2012/2013 and 2013/2014 growing season respectively. The stocking rate has been calculated using the following equation:

SR = STAY ÷ SN ÷ FRD ÷ 180

Where:

STAY: Site total allowable yield for 100 ha.

SN: sheep no.

FRD: feed requirements per head per day (2 kg on dry matter basis).

180: grazing period.

Grazing Cost (GC)

It was calculated based on the site allowable dry yield dependent on the following equation:

GC = STAY * BBSAC

Where:

STAY: Site total allowable yield for 100 ha.

BBSAC: Barley, bran and straw average cost.

Experimental Design and Statistical Analysis

The experiment was analyzed using Randomized Complete Block Design (RCBD) with three replicates. Years were added as independent variable so data were analyzed using split block in RCBD arrangement. Years were in the main plots and the rangeland systems were in the sub-plots. A general linear model (GLM) procedure was used for analyzing the data [17]. The independent variables included in the model were years and rangeland systems, while the dependent variables were FSFY, FSBY, FSDY, FSADY, NVFY, NVDY, NVAY, TAY, SR and GC.

RESULTS

Rainfall Amounts

The rainfall amounts was 154, 124 and 120 mm for 2011/2012, 2012/2013 and 2013/2014 growing seasons, respectively. Figure 1 shows the monthly rainfall amounts at Mafraq governorate 2011/2012, 2012/2013 and 2013/2014 growing seasons.

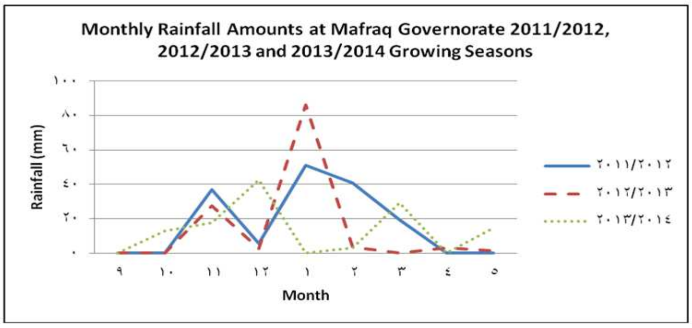

Figure 1: Monthly Rainfall Amounts at Mafraq Governorate 2011/2012, 2012/2013 and 2013/2014 Growing Seasons

Native Vegetation

Fresh yield had significance differences (P = 0.0002) between years. It was recorded 2135.2, 1647.7 and 1484 kg ha^{-1} for 2012, 2014 and 2013, respectively. Also, Fresh yield showed significantly different between the rangeland systems (P < 0.0001). It was recorded 2671.6, 2168.5 and 418.4 kg ha^{-1} for native vegetation, fodder shrubs and open access systems, respectively.

Interaction Effect between Years and Rangeland Systems

Fodder Shrubs

Fodder shrubs fresh, browse, dry and allowable yield showed high significant differences ($P \leq 0.01$) for the interaction between years and rangeland systems. The interaction between year 2012 and fodder shrubs system showed the highest yield. The fodder shrubs fresh yield was 1154.5, 899.0 and 662.1 kg ha^{-1} for 2012, 2013 and 2014 years, respectively. The fodder shrubs browse yield was 671.4, 284.4 and 405.7 kg ha^{-1} for 2012, 2013 and 2014 years, respectively. The fodder shrubs allowable yield was 138.4, 51.2 and 92.5 kg ha^{-1} for 2012, 2013 and 2014 years, respectively.

Native Vegetation Dry, Allowable and Total Fresh Yield

The interaction between treatments fodder shrubs, native vegetation and year 2012 were significantly different ($P > 0.01$) while open access with all years showed the lowest yield (Table 1).

Total Dry, Allowable, Site Yield and Stocking Rate

The interactions between treatments fodder shrubs, native vegetation and year 2012 were significantly different ($P > 0.01$) while open access with all years showed the lowest yield (Table 2 & 3).

Grazing Cost

The interaction between treatments fodder shrubs and year 2012 showed high significance ($P > 0.01$) while open access with all years showed the highest grazing cost (Table 3).

Table 1: The Interaction between the Rangeland Systems and Years for Native Vegetation Dry Yield (NVDY), Allowable Yield (NVAY) and Total Fresh Yield (TFY) at Khanasri Station

System	Year		
	2012	2013	2014
Native Vegetation Dry Yield (Kg/Ha)			
Fodder shrubs	875 a	446 d	504 cd
Native vegetation	808 ab	639 c	661 bc
Open	158 e	132 e	131 e
Native Vegetation Allowable Yield (Kg/Ha)			
Fodder shrubs	525 a	268 d	302 cd
Native vegetation	485 ab	383 bc	397 bc
Open	95 e	79 e	78 e
Total Fresh Yield (Kg/Ha)			
Fodder shrubs	3913 a	2682 bc	2627 bc
Native vegetation	3171 b	2257 c	2587 bc
Open	477 d	386 d	392 d

Means with the same letter are not significantly different for each indicated measure.

Table 2: The Interaction between the Rangeland Systems and Years for Total Dry Yield (TDY), Total Allowable Yield (TAY), and Site Total Allowable Yield (STAY) at Khanasri Station

System	Year		
	2012	2013	2014
Total Dry Yield (Kg/Ha)			
Fodder shrubs	1105 a	531 c	658 bc
Native vegetation	808 b	639 bc	661 bc
Open	158 d	132 d	131 d
Total Allowable Yield (Kg/Ha)			
Fodder shrubs	663 a	319 c	395 bc
Native vegetation	485 b	383 bc	397 bc
Open	95 d	79 d	78 d
Site Total Allowable Yield (Kg)			
Fodder shrubs	66302 a	31866 c	39472 bc
Native vegetation	48450 b	38331 bc	39688 bc
Open	9457 d	7895 d	7835 d

Means with the same letter are not significantly different for each indicated measure.

Table 3: The Interaction between the Rangeland Systems and Years for Stocking Rate and Grazing Cost at Khanasri Station

System	Year		
	2012	2013	2014
Stocking Rate (Head/Ha/180 Day)			
Fodder shrubs	0.62 a	0.34 b	0.38 b
Native vegetation	0.45 b	0.41 b	0.38 b
Open	0.09 c	0.09 c	0.08 c
Grazing Cost (Jd)*			
Fodder shrubs	10277 a	4939 c	6118 bc
Native vegetation	7510 b	5941 bc	6152 bc
Open	1466 d	1224 d	1215 d

** The currency unit was 1 US$ = 0.708 Jordanian Dinar (JD) during the present study period.*

Means with the same letter are not significantly different for each indicated measure.

DISCUSSIONS

The study objectives were to determine the effect of rangeland rehabilitation on feed costs, rangeland productivity, and stocking rate. Our present study shows that the total yield was higher in the two protected areas than in the open access. These results agree with Brown and Al Mazrooei [18] and Belsky [19] who showed that cessation of grazing can increase plant cover. Also, Abdallah and Chaieb [20] suggested that the benefit effect increases with protection. The slope of the decline in average grazing and stocking rate varies greatly from year to year. These differences may be due to the differences of seasonal rain fall which affect the native vegetation cover and forage quantity and quality.

The high yield in 2012 was attributed to the high rainfall during that year in comparison with those of 2013 and 2014. While, the higher yield in 2014 than 2013 was attributed to late rainfall failing in March and May (Figure 1).The feeding cost of fodder shrubs and native vegetation was decreased by 86% and 80% during 2012 year, 75% and 79% during 2013 year and 79.1% and 79.3% during 2014 year, respectively. The year 2012 was more effective or profitable in comparison with the results of 2013 and 2014 due to the higher rainfall. This is shed the lights on the importance of rangeland protection which has been shown in our previous work [21] and in Ben salem and others work [22] who indicated that fodder shrubs planting increase the biomass production. Al-Satari and others [21] showed that native vegetation dry yield was increased from 213.47 kg ha^{-1} for non-protected to 923.16 kg ha^{-1} for protected treatments. While, Ben Salem and others [22] reported that old man saltbush (*Atriplex nummularia* Lindl.) has received increasing interest as livestock forage and valuable revegetation species on marginal saline lands, especially in arid zones of Australia, West Asia and North Africa regions. Oldman saltbush adapted to drought and water and soil salinity, and it produces important consumable biomass in areas where other crops cannot grow [9]. Also, Al-Karablieh and Jabarin [11] showed that the rangeland cooperatives have lower feeding costs and sustainable use of resources compared to open access and governmental reserves. They further mentioned that in order to achieve sustainable rangeland resources; the fencing and other overhead costs of governmental reserves could be saved and directed towards building a new institutional form of rangeland management based on the participation of the local community. Stocking Rate (head per 180 day) has been increased 705% and 516% in fodder shrubs and native vegetation systems in comparison with open system, respectively. Grazing cost (JD $head^{-1}$) has been increased 701% and 614% in fodder shrubs and native vegetation systems in comparison with open system, respectively. Those results were showed the importance of fodder shrubs planting and rangeland protection on rehabilitation of the degraded rangeland. Those results will be attributed to growth habit of woody plants undergo secondary growth originating from secondary or lateral meristems and have obviously apical dominance, whereas non-woody plants have primary growth [23].

CONCLUSIONS

In rangeland areas that subjected to deterioration because of drought, cultivation for barley, shrubs cutting and uprooting and overgrazing, rehabilitation and restoration were showed good remedy and increase both grazing yield and stocking rat. Authors concluded that both fodder shrubs and native vegetation systems were increased rangeland productivity, stocking rate and decreasing sheep feeding cost. So, they are recommended to decrease the feeding cost and increase the profitability. It will be suggested that detilated study about native plants palatability and livestock behavior.

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