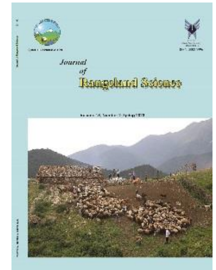
Contents available at ISC and SID
Journal homepage: www.rangeland.ir



Research and Full Length Article:

Forage Loss Valuation under Traditional Pastoralism in Arid to Semiarid Rangelands of Iran

Azam Khosravi Mashizi[A], Mohsen Sharafatmandrad[A*]
[A]Associate Professor, Department of Ecological Engineering, Faculty of Natural Resources, University of Jiroft, Jiroft, Iran, *(Corresponding author). E-mail: mohsen.sharafatmandrad@gmail.com

Received on: 09/06/2021
Accepted on: 07/03/2022
DOI: 10.30495/RS.2023.689644

Abstract. Economic valuation of rangelands is one of the best methods for conservation goals. A study was conducted to assess the economic value of forage loss under the two main forms of traditional pastoralism i.e. sedentary pastoralism and nomadism in historic grazing semiarid rangelands in Khabr National Park, Kerman province, Iran in 2019. Forage production was measured by clip-and-weigh method and forage quality was assessed using Crude Protein (CP) and Acid Detergent Fibre (ADF) indices. The replacement cost method was used for forage valuation and Total Digestible Nutrients (TDN) was used as the principal character of forage value. Forage production was decreased by 65% and 78% under nomadism and sedentary pastoralism respectively as compared to exclosure. Assessing species distribution along grazing gradient, using Detrended Correspondence Analysis (DCA), showed that forage quality decreased as grazing intensity increased due to plant composition change. *Lathyrus annuus* and annual grasses were the highest and lowest value forage, respectively. The forage values for exclosure area, near exclosure area and near village and pastoral tent were 75 $, 20-25 $ and 6-10 $.ha^{-1}.year^{-1}, respectively, indicating 65 to 92% reduction in the forage value in traditional pastoralism forms than to exclosure area. Therefore, there was priority to perform appropriate grazing systems such as rest rotational grazing to improve the condition of historic grazing lands and pastoral's income.

Key words: Ecosystem; Grazing; Exclosure; Economical value; Nomadism

Introduction

Rangelands have high economic and social value and provide variety ecosystem services for stakeholders (Bostan *et al.,* 2018; Shahraki *et al.,* 2015). Humans usually assign small value to rangelands, particularly compared to tropical or temperate forests (Martin-Lopez *et al.,* 2012). In contrast to mesic rangelands that have been converted to agricultural lands, arid and semiarid rangelands continue to be used as grazing lands (Oñatibia *et al.,* 2015). Rapid increases in human population and the increasing demand for livestock populations have intensified grazing pressure on rangelands (Na *et al.,* 2018). The type of range management can alter quality and quantity of goods and services provided by these ecosystems (Fox *et al.,* 2009).

Pastoralism is an economic activity involving animal husbandry in rangelands and it includes different forms (e.g. Nomadism and sedentary pastoralism). In sedentary pastoralism, pastorals are inhabited in villages and their herds graze in rangelands near villages year-round. In nomadism, nomads and their families live in the tents and move with their herds from winter rangelands to summer rangelands and vice versa (Cummins, 2009). Historically, pastoralism is an ecological adaption to harsh environment in arid to semiarid and lands.

Pastoralism was traced back to 10,000 years ago in Iran (Zeder and Hesse, 2000), but rangeland degradation has substantially increased over the past four decades. Pastorals' livelihood is increasingly confronted to various ecological stresses (Kassahun *et al.,* 2008) because of the loss of ecosystem services resulted from rangelands degradation (Oñatibia *et al.,* 2015). Hence, considerable efforts have recently been directed to show the value of ecosystem services loss in the rangelands to confirm conservation plans.

For pastorals, forage supply is the main provisioning service of rangeland ecosystems (Yahdjian *et al.,* 2015). Forage value is especially important where domestication activities have been historically present for over 10,000 years such as the Mediterranean region and countries such as Iran (Vahidi *et al.,* 2014). Pastoral's livestock productions supply about one-third of revenue derived from the agriculture which is about 20% of the total non-oil GDP in Iran (Kamalzadeh *et al.,* 2008). Forage provision is the portion of aboveground biomass that can be consumed by domestic herbivores (Oñatibia *et al.,* 2015). Rangeland forage has the lowest production cost for feeding livestock compared to the other fodder sources (e.g. wheat, corn, barley, alfalfa) (Arzani, 2009). Rangeland forage is freely delivered by ecosystem, but being free is not meant to be worthless.

In recent environmental evaluation, the forage produced in rangelands is of great value. Valuing rangeland forage is needed to adjust the appropriate grazing fee for public lands (Torell *et al.,* 1993). Replacement cost is a technique for evaluation of ecosystem functions which is usually used for valuing forage production in rangelands. For example, Zhang and Yiqing (2005) used this technique (coal market price) to estimate the forage production price by considering the price of organic matter, dry weight of organic matter, the quality of the coal and the amount of heat from the dry weight of the organic matter. In another study, Rastgar *et al*. (2013) used the equivalent price of barley under the replacement cost approach to estimate the forage value of summer rangelands in Mazandaran province, Iran. Eskandari *et al*. (2008) considered the value of 1 kg of forage equal to 0.7 of the market price of barley.

It is of great importance to know the efficiency of different rangeland management practices on the variations of forage production in rangelands. In the rangelands under traditional management approaches (i.e. Traditional pastoralism forms), it appears the amount of forage loss is higher. Therefore, the current study aimed to 1) measure amount of forage production in arid to semiarid rangelands under two main forms of traditional pastoralism (nomads and sedentary pastoralism), 2) assess economic value of produced forage and 3) compare rangelands with different grazing intensities and pastoralism forms based on the value of forage loss.

Materials and Methods

Study area

This study was conducted in an arid to semiarid rangeland located in the Baft county, southeastern Iran (28º47´ to 29º1´N and 56º18´ to 56º33´E). This region covers an area about 314.22 km^2. The long term mean annual precipitation and temperature are 340.8 mm and 17.6ºC, respectively. The area consists of pure stand of *Artemisia aucheri* which is grazed mostly under sedentary pastoralism and nomadism.

Measuring forage quantity and quality

About 55 % of the area (the exclosure area) is surrounded by fences and ditches excluding grazing livestock for more than 25 years (Fig. 1). A 50 m radiating zone away from livestock corrals in the village and the nomadic tents was considered as areas with high grazing intensity (Khosravi Mashizi *et al.,* 2012; Singh *et al.,* 2013). The area between the exclosure and high grazing intensity considered as area with light or moderate grazing intensity (Liang *et al.,* 2009). The areas with 50 m distance from exclosure were exploited about 50% in both nomadic and sedentary pastoralism rangelands, which were considered as areas with moderate grazing intensity (Niko and Rahimi Dehcheraghi, 2016). Hence, five areas were selected for sampling: (1) exclosure, (2) near exclosure for nomadism, (3) near nomadic tents, (4) near exclosure for sedentary pastoralism, and (5) near villages. As sampling sites were close to each other, they were identical in terms of environmental conditions and topography (slope, direction and elevation).

In each area, forage quantity (production), forage quality, and grazing intensity were measured. Random-systematic sampling was performed in the 5 areas. Five 1×1m quadrates were randomly established along four 50-m transects according to the vegetation type and distribution.

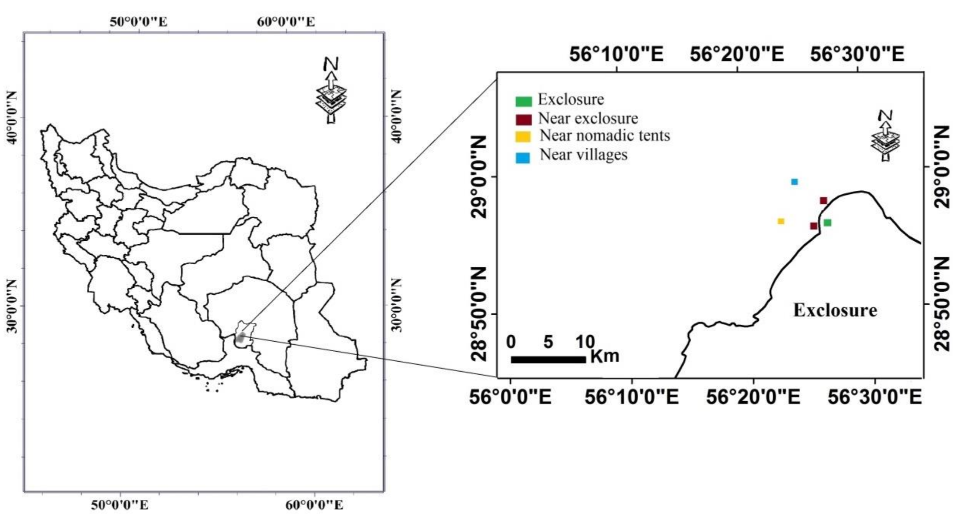


Fig. 1. The map of studied area

Rangeland production was measured by clip-and-weigh method in 100 quadrats. Current year's growth was considered as forage production which is the above-ground biomass produced during the previous 12 months. Therefore, green leaves and supple twigs of shrubs, annual forbs and grasses at the ground surface were clipped, and all samples were then oven dried at 60°C until obtaining a constant weight, and samples was finally weighed.

Nitrogen content (N) of samples was determined by Kjeldahl method (Sáez-Plaza *et al.*, 2013). The acid detergent fiber (ADF) was measured according to the method of Van Soest *et al.* (1991). Crude protein (CP), Dry matter digestibility (DMD) and metabolisable energy (ME) were measured using N% and the ADF % as follows:

$$\%CP = 6.25\%N$$

$$\%\mathrm{DMD} = 83.58 - 0.824\%\mathrm{ADF} + 2.262\%\mathrm{N}$$

$$\mathrm{ME}\ (\mathrm{Mj/Kg/DM}) = 0.17\%\mathrm{DMD} - 2$$

In this study, total digestible nutrient (TDN) was used to uniform different forage. TDN of grazing species was measured based on their ADF (Horrocks and Vallentine, 1999):

TDN = (-1.291 x ADF) + 101.35

The dung counting technique was used to determine grazing intensity in sampling sites. To do so, the number of livestock dungs encountered within twenty 1×1m quadrates was counted in each area.

Replacement cost method

Due to the specificity of barley price in the market, barley price was used to estimate the Rial value of forage (Rastgar *et al.*, 2013). The method of government guaranteed (supportive) pricing policy was used to estimate the price of barley. In this method, by announcing a reasonable price, farmers are somewhat protected against severe price fluctuations (Koopahi, 2006). The guaranteed price of barley has been announced as 0.56 $ per kilogram in 2020. Therefore, this price was used to determine the value of forage. Barley weight equivalent for forage was also estimated using TDN of plants. Thus, the total TDN of all plant species was divided into barley TDN and then, it was multiplied by the dry production of each rangeland plant. Hence, the weight equivalent of barley in kilograms per hectare was estimated for each area.

Data analysis

Prior to analyses, data were tested for normality by Kolmogorov-Smirnov test. One -way analysis of variance (ANOVA) followed by the least significant difference (LSD) test was performed to compare sampling sites based on dung density. ANOVA was applied on data to test different pastoralism forms and sampling sites in terms of forage production. Data were analyzed using SPSS Statistics V22.0. Detrended Correspondence Analysis (DCA) was used to assess the relationships between forage production and grazing intensity. DCA has been shown to provide an accurate output when the grazing has a dominant impact and it can be a useful tool for gradient extraction and the reduction of dimensionality (Ejrnaes, 2000). DCA was performed with the PC-ORD v4.0 (McCune and Mefford, 1999).

Results

There were no significant differences between near exclosure areas in terms of dung count, but their differences with near nomadic tent and village areas were significant ($p<0.001$, Table 1). The differences between near nomadic tent and village areas were not significant.

Table 1. Differences between different sampling sites in dung counts. Means followed by the same letter are not significantly different according to (LSD) test (P<0.05)

Pastoralism forms	Grazed sites	Dung (Number)
Nomadism	Near exclosure	15.1±7.2a
	Near tents	5.1±4.3b
Sedentary pastoralism	Near exclosure	16.8±9.1a
	Near villages	6.3±5.1b

The results of ANOVA showed that pastoralism forms, areas, and their interaction had significant impact on the forage production ($p<0.001$, Table 2). The highest forage production was related to exclosure (152.25 $kg.ha^{-1}$). The mean forage production in nomadism and sedentary pastoralism rangelands were 54.12 and 34.23 $kg.ha^{-1}$, respectively. There were no significant differences between areas outside the enclosure, i.e. near exclosure, near tent and near village rangelands in forage production ($p<0.05$).

Table 2. Differences between different sampling sites and pastoralism forms in forage production ($kg.ha^{-1}$). Means followed by the same letter are not significantly different according to (LSD) test (P<0.05)

Pastoralism forms	Grazed sites	Forage production ($kg.ha^{-1}$)
	Exclosure	152.25±35.45a
Nomadism	Near Exclosure	78.89±21.4b
	Near Tents	44.45±12.76c
Sedentary pastoralism	Near Exclosure	68.56±18.21b
	Near Villages	30.57±8.73c

CP% and ADF% were measured for plant species sampled in quadrats (Table 3). *Lathyrus annuus*, *Astragalus podolobus* (Fabaceae) and *Tragopogon jezdianus* (Astraceae) had the highest CP% respectively. The lowest CP% was related to *Aegilops cylindrica* (Poaceae) followed by *Dianthus orientalis* (Caryophyllaceae). *Aegilops cylindrica* (Poaceae) and *Kochia prostrate* (Chenopodiaceae) had the highest ADF%, respectively. The highest ME (MJ.Kg.DM) was measured in *Astragalus podolobus* and *Lathyrus annuus* (Fabaceae). The lowest ME (MJ.Kg.DM) was related to *Aegilops cylindrica* (Poaceae) and *Kochia prostrate* (Chenopodiaceae) respectively.

The contribution of each plant species in forage production for each area is presented in Table 4. Result showed that *Artemisia aucheri* had the highest contribution in supplying forage in exclosure and areas near exclosure (36-45%), but *Bromus tectorum* was the main plant species providing forage in areas near nomadic tent and village with 42 and 23% contribution, respectively (Table 4).

Table 3. CP%,. ADF%, DMD% and ME (MJ.Kg.DM) of plant species sampled in the study area

Plant species	Family	CP%	ADF%	DMD%	ME (MJ.Kg.DM)
Aegilops cylindrica	Poaceae	5.31±0.4	66.5±3.6	30.65±5.4	3.21±0.4
Agropyron intermedium	Poaceae	8.43±0.6	47.1±4.6	47.77±3.6	6.12±0.5
Alhagi camelorum	Fabaceae	11.42±1.2	47.52±8.3	48.50±6.3	6.25±0.6
Alyssum bracteatum	Brassicaceae	9.67±0.4	47.34±5.4	48.02±2.8	6.16±0.8
Artemisia aucheri	Astraceae	8.35±0.3	42.67±3.8	51.39±7.6	6.74±1.2
Astragalus microphysa.	Fabaceae	10.78±1.3	43.57±4.6	51.52±5.8	6.76±0.6
Astragalus mucronifolius	Fabaceae	11.43±1.1	32.87±3.2	60.58±10.3	8.30±1
Astragalus podolobus	Fabaceae	17.5±2.5	24.54±3.6	69.64±12.5	9.84±0.6
Avena fatua	Poaceae	7.44±0.3	46.65±4.5	47.78±8.6	6.12±0.5
Bromus tectorum	Poaceae	6.26±0.4	38.60±5.3	53.98±3.8	7.18±1.2
Cousina stocksii	Astraceae	11.20±1.4	30.3±2.3	62.61±6.7	8.64±0.6
Dianthus orientalis	Caryophyllaceae	5.84±0.3	50.14±7.6	44.32±4.9	5.54±0.3
Echinops pungens	Asteraceae	8.32±0.5	45.34±6.2	49.18±6.7	6.36±0.5
Euphorbia helioscopia	Euphorbiaceae	7.45±0.2	57.87±5.9	38.54±3.6	4.55±0.2
Hordeum glaucum	Poaceae	6.34±0.3	43.26±4.3	51.17±8.6	6.53±0.5
Kochia prostrata	Chenopodiaceae	8.56±0.4	64.7±11.3	33.31±4.6	3.66±0.2
Lathyrus annuus	Fabaceae	18.55±1.3	27.15±3.6	67.87±12.3	9.54±1.3
Scariola orientalis	Astraceae	10.55±1.2	40.14±5.6	54.27±9.7	7.23±0.6
Stipa barbata	Poaceae	7.43±0.6	50.42±8.6	44.67±6.3	5.59±0.5
Taraxacum officinale	Asteraceae	8.13±0.3	32.76±3.6	59.47±7.1	8.11±1.2
Tragopogon jezdianus	Asteraceae	14.39±3.5	32.73±2.8	61.76±9.3	8.50±1.3
Ziziphora tenuior	Lamiaceae	8.11±1.2	43.78±4.6	50.39±5.6	6.57±1.1
Zygophyllum eurypterum	Zygophyllaceae	7.30±0.8	49.60±6.7	45.30±6.7	5.70±0.9

Standard error

Table 3. The contribution of plant species in forage production (%) in each sampling area

Plant species	Exclosure	Nomadism		Sedentary pastoralism	
		Near exclosure	Near tents	Near exclosure	Near villages
Aegilops cylindrica	0	1	8.8	1	8.9
Agropyron intermedium	5.5	0	0	0	0
Alhagi camelorum	0	0	0	0	15.6
Alyssum bracteatum	1.1	2.3	1.4	3.5	0
Artemisia aucheri	36.6	45.7	5	38	4.7
Astragalus microphysa.	3.5	1.3	1	4.5	0
Astragalus mucronifolius	5.1	3.1	2	3.4	2.8
Astragalus podolobus	2.3	2	0	1	0
Avena fatua	2.1	1.5	0	2	0
Bromus tectorum	0	8.7	42	12	23
Cousina stocksii	0	2.3	8.3	2.5	7.7
Dianthus orientalis	1.3	1	0	1	0
Echinops pungens	1	3.4	0	4.1	0
Euphorbia helioscopia	0	5.1	0	4.7	0
Hordeum glaucum	0	6.3	3.8	7.4	4.6
Kochia prostrata	0	0	5.3	0	18.9
Lathyrus annuus	4	0	0	0	0
Scariola orientalis	2.3	5.3	0	23.7	0
Stipa barbata	3.4	1.5	0	1.8	0
Taraxacum officinale	1.2	5.1	22.4	5.2	15.7
Tragopogon jezdianus	3.7	0	0	0	0
Ziziphora tenuior	12.3	1	0	0	0
Zygophyllum eurypterum	14.56	3.3	0	4.2	0
Sum	100	100	100	100	100

DCA was used to assess the relationships between forage production and grazing intensity. The first DCA axes account for 68% variation in data, showing a grazing gradient in our study area. Exclosure, areas near exclosure and near nomadic tent and village are respectively distributed from the left to right (Fig. 2). DCA graph shows that plant species distributed along samples areas for example *Lathyrus annuus*, *Agropyron intermedium*, *Tragopogon jezdianus* with exclosure area, *Artemisia aucheri*, *Ziziphora tenuior*, *Astragalus mucronifolius*, *Astragalus podolobus*, *Alyssum bracteatum* and *Zygophyllum eurypterum* with areas near exclosure and *Bromus tectorum*, *Aegilops cylindrica*, *Alhagi camelorum* with areas near nomadic tent and village.

The value of forage in studied sites was measured using the weight equivalent of barley in kilograms per hectare (Table 5). The highest forage value belonged to the exclosure (75, $.ha^{-1}.year^{-1}). The lowest forage value was related to the areas near villages (6, $.ha^{-1}.year^{-1}). The decrease in forage value in pastoralism forms compared to exclosure is presented in Fig. 3. The highest decrease (value per hectare) was related to the areas near village and nomadic tent (87-92%).

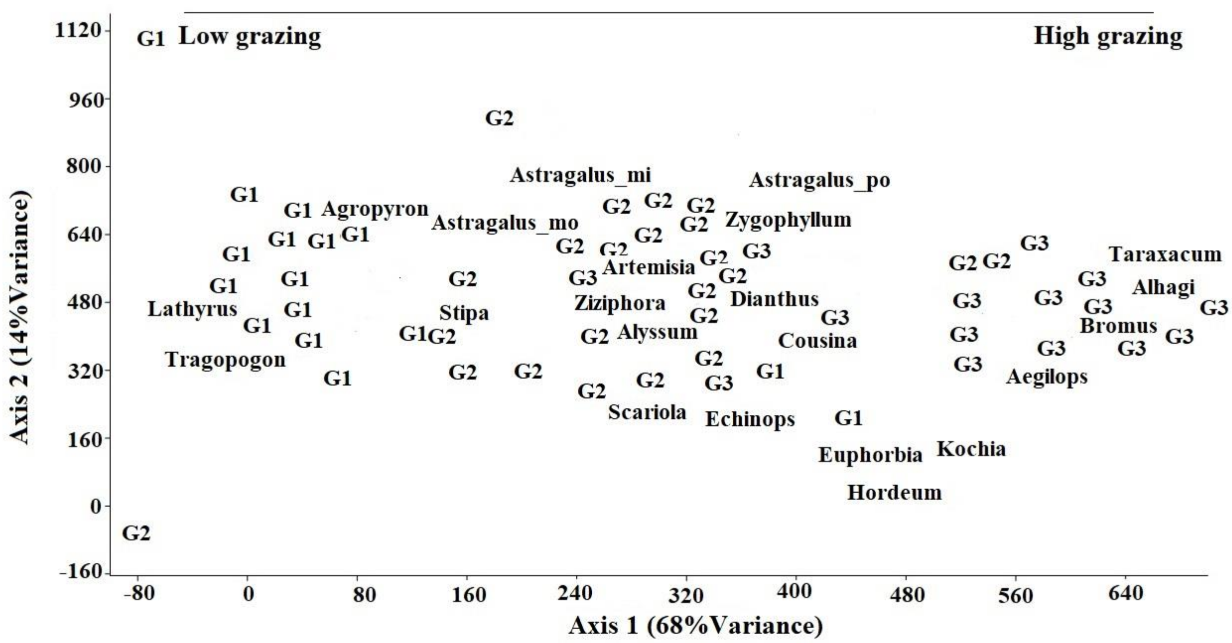


Fig 2. Distribution of plant species and sampling sites along two first axes of Detrended Correspondence Analysis (DCA): exclosure (G1), near exclosure (G2), near nomadic tents and village (G3)

Table 5. Quality and value of forage produced in different sampling sites

Sampling Sites	CP%	ADF%	TDN (g.kg^{-1})	Price of forage ($.ha^{-1}.year^{-1})
Exclosure	10.67±4.35	28±5	65.202	75
Near exclosure_nomadism	8.92±1.56	46±12	41.964	25
Near nomadic tents	6.78±1.23	56±8	29.054	10
Near exclosure_sedentary	8.45±2.1	48±13	39.382	20
Near villages	6.32±1.65	58±11	26.472	6

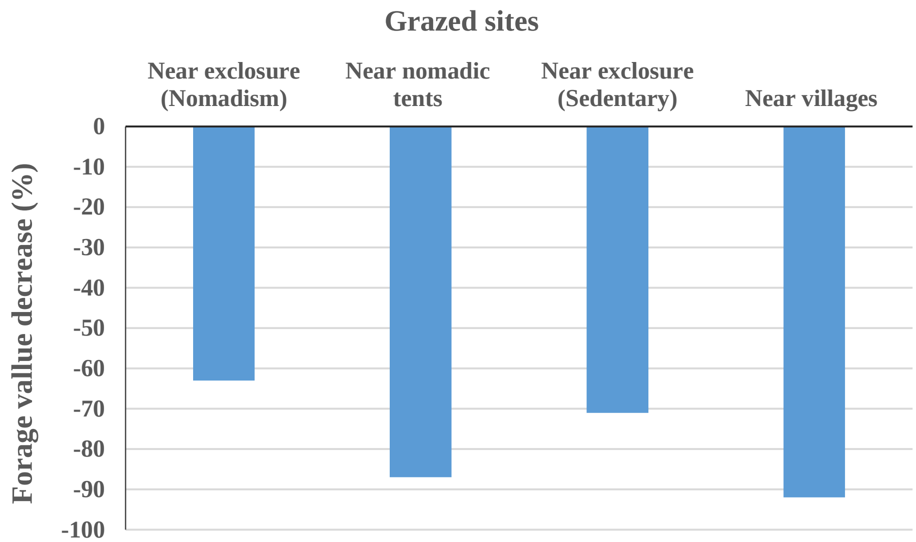


Fig 3. Relative decrease of forage value per hectare in sites under grazing compared to exclosure

Discussion

The studied arid to semiarid shrublands could provide 152 kg.ha^{-1} forage with economic value of 75 \$.ha^{-1}. Annual income from forage was reported to be about 57 \$.ha^{-1} in USA (Costanza *et al.*, 1997), 73-117 \$.ha^{-1} in Australia (Monjardino *et al.*, 2004), and 4.3 \$.ha^{-1} in Iran (Eskandari et al., 2008). This high variation can be attributed to the difference between rangelands in terms of condition and time of study due to elevated inflation rate.

Decrease in forage quantity and quality caused to forage value decline in the areas under grazing. There was a significant difference between exclosure, near exclosure and near nomadic tent and village areas in terms of forage production ($p<0.05$). However, dung counts showed that grazing intensity was not very severe in areas near exclosure. Forage decrease in the areas near enclosure showed that they had experienced historical severe grazing intensity (50-55% of forage were utilized) and the areas near nomadic tent and village had endured very severe grazing intensity (70-80% of forage were utilized) (Holechek *et al.*, 2006). Percentage decrease in forage value is high in areas under grazing, showing the continuous overgrazing for recent decades in the area. Monjardino *et al*. (2004) reported a negative value of up to 42 \$.ha^{-1}.year^{-1} at rangelands with high grazing intensity. Egan and Watts (1998) estimated 1992 as real-price of a public land animal unit month in Nevada which decreased from \$72in 1978 to \$22in 1994 due to stocking rate increment.

Herbivores grazing usually do not have much effect on vegetation composition at short time. Unless it is so widespread that plant species cannot stock energy or loss competition capability in ecosystems (Eskandari *et al.*, 2008). Desirable species (palatable species) were disappeared from areas with historical grazing, but *Artemisia aucheri* was still the dominant species. While areas with very severe grazing, not only perennial species were mostly disappeared but also annual and undesirable species were dominated. Severe and very severe grazing intensities had negative impacts on plants vigor that could require years of recovery (Briske *et al.*, 2008). A large number of studies have shown that very severe grazing causes plant composition to change (Hillenbrand *et al.*, 2019).

DCA revealed exclosure is related to palatable forb species (*Lathyrus annuus* and *Tragopogon jezdianus*) and perennial grass (*Agropyron intermeddium*) which were not observed in areas under grazing. *Lathyrus annuus* as an herbaceous legume generally contains lower levels of fiber and higher concentrations of protein as compared to grasses (Lee, 2018). It has the highest pliability and sensitivity to grazing. Louhaichi *et al*. (2009) reported disappearance of legume species of semiarid rangeland ecosystems duo to grazing. *Lathyrus annuus* had the highest forage value duo to the highest TDN in comparison to other species. This is not the case for all herbaceous legumes in our study, e.g. *Alhagi camelorum* as a legume with high CP and TDN is considered as an unpalatable invader species with high abundance in areas near the villages.

On the other hand, *Agropyron intermedium* as a species with low TDN and subsequently low price is considered as a desired species sensitive to grazing which has disappeared in areas under grazing. This shows that the palatability of some species, especially grasses may be unrelated to their forage quality and TDN (Raufirad *et al.*, 2013). *Agropyron intermedium* has also lower forage quantity (production) as compared to forbs and shrubs. Depending on leaf orientation, plants with longer leaves such as *Agropyron intermedium* can first create impediments to its own self by self-shading (Tiwari *et al.*, 2012) thereby, reducing light interception at the lower canopy level, which results in the lower overall photosynthetic activity, and ultimately productivity (Ivanova *et al.*, 2018).

Undesirable annual grasses i.e. *Aegilops cylindrica* and *Bromus tectorum* were distributed in severely grazed areas. These invasive species have the lowest forage quality and value. Annual grasses usually invade rangelands after reduction in perennial herbs and shrubs (Hillenbrand *et al.,* 2019). Annuals invade manipulated environment because they allocate more of their reserves to seed production (Bassel *et al.*, 2008). A plant species should have at least 7% CP for the maintenance of an animal unit (NRC, 2001). Therefore, these invasive species could not supply sufficient energy for livestock maintenance due to low CP.

Generally, plant species with the highest value and palatability are not selected as key forage species because their utilization does not provide information on the overall utilization of the management unit. Shrub species such as *Artemisia aucheri, Astragalus spp.* and *Zygophyllum eurypterum* with fair palatability and abundance even in areas near exclosure could be selected as the key forage species in the study area. In general, maintenance of a desirable mixture of herbaceous and woody vegetation is a key component of sustainable ecosystem management in arid to semiarid rangelands.

Livestock needs protein for maintaining growth and reproduction. The deficiency of proteins leads to reduced appetite, low feed intake in livestock, resulting in slow weight gain and development of livestock (Hussein and Durrani, 2009). Shrubs generally supplied higher CP% than grasses and most forbs, which is in accord with other researches (Hussein and Durrani, 2009). However, we found that forbs and grasses were highly grazed by goats and disappeared from rangelands which is in accord with Foroughbakhch *et al.* (2013) who concluded that goats mostly consume forbs in comparison to other plant species. Although most studies showed that goat prefer shrub species and spend more time consuming browse (Abaye *et al.*, 2011).

All areas under grazing statistically had the same livestock dung density ($p>0.05$).

However, nomad and sedentary pastoral rangelands had significantly different forage supplies ($p<0.05$). Nomad rangelands with season-long grazing were more successful in forage production compared to sedentary pastoral rangelands with continuous grazing. Forage with TDN% more than 50% is essential to supply feeding requirement of a livestock unit (Arzani *et al.,* 2010). Therefore, the studied rangelands, which are grazed by nomads and sedentary pastorals livestock, are not able to provide sufficient forage to meet livestock needs because their TDN% is less than 50%.

Pastoral mobility in very important in highly variable environments such as arid and semiarid rangelands and nomadism is an ideal adaptation to these areas compared to sedentary pastoralism (Salzman, 2004). Na *et al*. (2018) pointed out that season-long grazing in nomadism has less negative effect on biomass than continues grazing in sedentary pastoralism.

Despite many researches on the relationships between grazing management and forage production, still impact of different rangeland management on forage production is unclear. Some researchers reported few forage and livestock benefits from rotational grazing (Heitschmidt *et al.,* 1990). Briske *et al*. (2008) pointed out that rotational systems are the best grazing management compared to continuous and season-long grazing strategies. In the study area, herds are kept in a defined boundary for the entire grazing season and are allowed to use the forage resources freely without being rotated. Hence, it is needed to apply rest rotational grazing to improve rangeland condition in both nomad and sedentary pastoral rangelands. Cyclic movement of livestock within rangeland permits forage plants to photosynthesize, reproduce and disperse their seeds and plant seedlings are established (Shamhart *et al.,* 2012).

Conclusion

In the study area, forage production was decreased to 50-55% in areas near exclosure and 60-78% in areas near nomadic tent and village. Plant composition change due to overgrazing was the main cause of forage production decrease. In areas near exclosure, desirable plants were disappeared and plants with medium palatability comprised the highest portion of the forage. In areas near nomadic tent and village not only perennial species were disappeared, but also invasive undesirable species (mostly annual grasses) were dominated. *Lathyrus annuus* and annual grasses were respectively the most and least important plant species in terms of forage value in the study area. Forage value was dropped to 60% in severely grazed areas and to 87-92% in very severely grazed areas as compared to exclosure. Therefore, there is a serious need to perform appropriate grazing systems such as rest rotational grazing to improve rangeland condition.

Funding: This research was supported by University of Jiroft under the grant number 4811-98-3.

References

Abaye, A.O., Webb, D.M., Zipper, C., Luginbuhl, J., 2011. Managing shrub-infested, postmined pasturelands with Goats and cattle part II. Effects on forage biomass, nutritive values and animal performance, Produced by Communications and Marketing, College of Agriculture and Life Sciences, Virginia Polytechnic Institute and State University:http://pubs.ext.vt.edu/ CSES/CSES-3/CSES-3. 5p.

Arzani, H., Ahmadi, Z., Azarnivand, H., Bihamta, M.R., 2010. Forage quality of three life forms species in semiarid and semi humid regions in different phonological stages, Journal of Desert, 15: 71-74.

Arzani. H., 2009. Forage quality and daily livestock from the rangeland. University of Tehran Press, Iran. 296p. (In Persian)

Bassel, G.W., Fung, P., Chow, T.F., Foong, J.A., Provartand Cutler, S.R., 2008. Elucidating the germination ranscriptional program using small molecules. Plant Physiol, 147: 143-55.

Bostan, Y., Fatahiardakani, A., Fehresti Sani, Masoud., Sadeghinia, M. 2018. A Pricing Model for Value of Gas Regulation Function of Natural Resources Ecosystems (Case Study: Sheikh Musa Rangeland, Mazandaran Province, Iran). Journal of Rangeland Science, 8(2): 186–200.

Briske, D.D., Derner, J.R., Brown, S.D., Fuhlendorf, W.R., Teague, K.M., 2008. Rotational grazing on rangelands: reconciliation of perception and experimental Evidence. Rangeland Ecology and Management, 61: 3-17.

Costanza, R., d'Arge, R., de Groot, R., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, R., Paruelo, J., Raskin, R.G., Sutton, P., van den Belt, M., 1997. The value of the world's ecosystem services and natural capital. Nature, 387: 253–260.

Cummins, B., 2009. Bear country: Predation, politics, and the changing face of Pyrenean pastoralism. Durham: Carolina Academic Press.

Egan, L.M., Watts, M.J., 1998. Some Costs of lncomplete Property Rights with Regard to Federal Grazing Permits. Land Econ., 74:171-185.

Ejrnaes, R., 2000. Can we trust gradients extracted by Detrended Correspondence Analysis? Journal of Vegetation Science, 11: 565–572.

Eskandari, N., Alizadeh, A., Mahdavi, F., 2008. Range management policies in Iran, Poneh Press, Iran, 196 p. (In Persian)

Foroughbakhch, R., Hernandez-Piñero, J.L., Carillo-Parra, A., 2013. Composition and animal preference for plants used for goat feeding in semiarid Northeastern Mexico. Journal of Animal and Plant Sciences, 23(4): 1034-1040.

Fox, W.E., McCollum, D.W., Mitchell, J.E., Tanaka, J A., Kreuter, U.P., Swanson, L.E., Evans, G.R., Heintz, H.T., Breckenridge, R.P., Geissler, P.H., 2009. An integrated social, economic, and ecological conceptual (ISEEC) framework for considering rangeland sustainability. Society and Natural Resources, 22: 593–606.

Heitschmidt, R.K., Conner, J.R., Canon, S.K., Pinchak, W.E., Walker, J.W., Dowhower, S.L., 1990. Cow/calf production and economic returns from yearlong continuous, deferred rotation and rotational grazing treatments. Journal of Production Agriculture, 3: 92–99.

Hillenbrand, M., Thompson, R., Wang, F., Apfelbaum, S., Teaguec, R., 2019. Impacts of holistic planned grazing with bison compared to continuous grazing with cattle in South Dakota short grass prairie.Agriculture, Ecosystems and Environment, 279: 156–168.

Holechek, J.L., Baker, T., Boren, J.C., Galt, D., 2006. Grazing impacts on rangeland vegetation: What we have learned. Rangelands, 28(1):7-13.

Horrocks, R.D., Vallentine, J.F., 1999. Harvested Forages. Academic Press, London, UK.

Hussein, F., Durrani, M.J., 2009. Nutritional evaluation of some forage plants from Harboi rangeland, Kalat, Pakistani. Pak. J. Bot., 41(3): 1137-1154.

Ivanova, L.A., Zolotareva, N.V., Ronzhina, D.A., Podgaevskaya, E.N., Migalina, S.V., Ivanov, L.A., 2018. Leaf functional traits of abundant species predict productivity in three temperate herbaceous communities along an environmental gradient. Flora, 239: 11–19.

Kamalzadeh, A., Rajabbeygi, M., Kiasat, A., 2008. Livestock production systems and trends in livestock industry in Iran. J. Agri. Soc. Sci., 4: 183–88.

Kassahun, A., Snyman, H.A., Smit, G.N., 2008. Impact of rangeland degradation on the pastoral production systems, livelihoods and perceptions of the Somali pastoralists in Eastern Ethiopia. Journal of Arid Environments, 72: 1265-1281.

Khosravi Mashizi, A., Heshmati, Gh.A., Sepehri, A., Azarnivand, H., 2012. Determining structure-functional zones around water points by soil and vegetation indicators in cold season rangeland of Kerman province (case study: Ko hpanj Bardsir). Journal of Range. 6: 46-57. (In Persian)

Koopahi, M., 2006. Introduction to agricultural economics. 10th edition, University of Tehran press, Iran, 532p. (In Persian)

Lee, M.A., 2018. A global comparison of the nutritive values of forage plants grown in contrasting environments. Journal of Plant Research, 131:641–654.

Liang, Y., Han, G., Zhou, H., Zhao, M., Snyman, H.A., Shan, D., Havstad, K.M., 2009. Grazing intensity on vegetation dynamics of a typical steppe in northeast Inner Mongolia. Rangeland Ecology & Management, 62 (4): 328-336.

Louhaichi, M., Salkini, A.K., Petersen, S.L., 2009. Effect of small ruminant grazing on the plant community characteristics of semiarid Mediterranean ecosystems. Int. J. Agric. Biol., 11: 681–689.

Martin-Lopez, B., Iniesta-Arandia, I., Garcia-Llorente, M., Palomo, I., Casado-Arzuaga, I., Del Amo, D.G., Gomez-Baggethun, E., Oteros-Rozas, E., Palacios-Agundez, I., Willaarts, B., Gonzalez, J.A., Santos-Martin, F., Onaindia, M., Lopez-Santiago, C., Montes, C., 2012. Uncovering ecosystem service bundles through social preferences. PLoS One, 7: 38970

McCune, B., Mefford, M.J., 1999. PC-ORD for Windows: Multivariate Analysis of Ecological Data, version 4. Glenden Beach, OR: MJM Software.

Monjardino, M., Pannell, D.J., Powles, S.B., 2004. The economic value of pasture phases in the integrated management of annual rye-grass and wild radish in a Western Australian farming system. Australian Journal of Experimental Agriculture, 44: 271–265.

Na, Y., Li, J., Hoshino, B., Bao, S., Qin, F., Myagmartseren, P., 2018. Effects of Different Grazing Systems on Aboveground Biomass and Plant Species Dominance in Typical Chinese and Mongolian Steppes. Sustainability, 10 (12): 4753; https://doi.org/10.3390/su10124753

Niko, Sh., Rahimi Dehcheraghi, M., 2016. Effect of various grazing intensities on qualitative and quantitative forage characters of Artemisia sieberi (Case study: Ghooshe and Loookeh in Semnan province). Journal of Rangeland, 10: 282-290. (In Persian)

NRC. 2001. Nutrient Requirements of Dairy Cattle, National Academy Press, Washington, DC, USA, 381p.

Oñatibia, G.R., Aguiar, M.R., Semmartin, M., 2015. Are there any trade-offs between forage provision and the ecosystem service of C and N storage in arid rangelands? Ecological Engineering, 77: 26–32.

Rastgar, Sh., Darijani, A., Barani, H., Ghorbani, M., Ghorbani, J., Bordi Sheikh, V., 2013. A new approach to economic valuation of the function of forage production of rangelands (Case Study: summer rangelands of Nour-rud Watershed in Mazandaran Province). Journal of Range and Watershed Management, 66: 347-357. (In Persian)

Raufirad, V., Ebrahimi, A., Arzani, H., Shojaei Asadeiye, Z., 2013. Investigation on Relationship between Palatability and Forage Quality in some of Rangeland Plants (Case Study: Karsanak rangelands of Chaharmahal-va-Bakhtiari Province). Journal of Range and Watershed Management, 8:111-120. (In Persian)

Sáez-Plaza, P., Michałowski, T., Navas , M.J., Asuero, A.G., Wybraniec, S., 2013. An overview of the Kjeldahl method of nitrogen determination. Part I. Early History, Chemistry of the Procedure, and Titrimetric Finish. Critical Reviews in Analytical Chemistry, 43: 224–272.

Salzman, P.C., 2004. Pastoralists: Equality, hierarchy, and the state. Westview Press, Cambridge, USA. 193p.

Shahraki, MR, Gholami Baghi, N., Sharafatmandrad, M., Behmanesh, B. 2015. Rangelands Goods and Services Local People Views and Priorities (Case Study: Hezarjarib Rangelands, Mazandaran Province, Iran). Journal of Rangeland Science, 5(3): 212- 221.

Shamhart, J., King, F., Proffitt, K., 2012. Effects of a Rest–Rotation Grazing System on Wintering Elk Distributions at Wall Creek, Montana. Rangeland Ecology & Management, 65: 129-136.

Singh, N.J., Bhatnagar, Y.V., Lecomte, N., Fox, J.L., Yoccoz, N.G., 2013. No longer tracking greenery in high altitudes: Pastoral practices of Rupshu nomads and their implications for biodiversity conservation. Pastoralism, 3: 16.

Tiwari, T.P., Brook, R.M., Wagsta, P., Sinclair, F.L.E., 2012. Effects of light environment on maize in hillside agroforestry systems of Nepal. Food Secur., 4: 103–114.

Torell, L.A., Van Tassell, L.W., Rimbey, N.R., Bartlett, E.T., Bagwell, T., Burgener, P., Coen, J., 1993. The value of public land for age and the implications for grazing fee policy. N.M. State Univ., Agr. Exp. Sta. Bull. No. 767. Las Cruces, N.M.

Vahidi, S.M., Tarang, A.R., Naqvi, A.U., FalahatiAnbaran, M., Boettcher, P., Joost, S., Colli, L., Garcia, J.F., Ajmone-Marsan, P., 2014. Investigation of the genetic diversity of domestic Capra hircus breeds reared within an early goat domestication area in Iran. Genet SelEvol., 17: 27-46.

Van Soest, P.J., Robertson, J.B., Lewis, B.A, 1991. Methods for dietary fiber, neutral detergent fiber and non-starch polysaccharides in relation to animal nutrition. Journal of Dairy Science, 74: 3583-3597.

Yahdjian, L., Sala, O.E., Havstad, K.M., 2015. Rangeland ecosystem services: Shifting focus from supply to reconciling supply and demand.

Frontiers in Ecology and the Environment, 13: 44–51.
Zeder, M.A., Hesse, B., 2000. The Initial Domestication of Goats (Capra hircus) in the Zagros Mountains 10,000 Years Ago. Science., 287: 2254.
Zhang, Y., Yiqing, L., 2005. Valuing or pricing natural and environmental resources? Journal of Environmental Science and Policy, 5: 179-186.

ارزش‌گذاری هدر رفت علوفه تحت دامداری‌های سنتی در مراتع خشک تا نیمه‌خشک ایران

اعظم خسروی مشیزی[الف]، محسن شرافتمندراد[الف*]

[الف]**دانشیار گروه مهندسی طبیعت، دانشکده منابع طبیعی، دانشگاه جیرفت، جیرفت، ایران**

[*]**(نویسنده مسئول)**، پست الکترونیک: mohsen.sharafatmandrad@gmail.com

چکیده. برای اهداف حفاظتی، ارزیابی اقتصادی خدمات اکوسیستم یکی از بهترین روش‌ها برای نشان دادن ارزش مراتع است. این مطالعه برای ارزیابی ارزش اقتصادی هدر رفت علوفه تحت دو شکل اصلی دامداری یعنی دامداری ساکن و عشایری در مراتع نیمه خشک واقع در پارک ملی خبر استان کرمان انجام شد. تولید کمی علوفه به روش قطع و توزین و کیفیت علوفه با استفاده از شاخص‌های پروتئین خام و ADF در ۵ محدوده (قرق، عشایری نزدیک قرق، نزدیک چادرهای عشایری، دامداری ساکن نزدیک قرق و نزدیک روستا) ارزیابی شد. در این مطالعه، از روش هزینه جایگزینی برای قیمت‌گذاری علوفه استفاده شد. از مواد مغذی قابل هضم (TDN) به عنوان ویژگی اصلی ارزش علوفه استفاده شد. تولید علوفه تحت مدیریت دامداری کوچ نشینی و دامداری ساکن به ترتیب ۶۵ و ۷۸ درصد در مقایسه با قرق کاهش یافت. ارزیابی توزیع گونه ها در طول شیب چرا، با استفاده از آنالیز تطبیق قوسگیر (DCA)، نشان داد که با افزایش شدت چرا به دلیل تغییر ترکیب گیاه، کیفیت علوفه کاهش می‌یابد. گونه *Lathyrus annuus* و گیاهان یکساله به ترتیب بیشترین و کمترین ارزش‌ترین گیاهان علوفه‌ای بودند. ارزش علوفه برای محدوده‌های قرق (۷۵ دلار در هکتار در سال)، نزدیک قرق (۲۰-۲۵ دلار در هکتار در سال)، نزدیک روستا و چادرهای عشایری به ترتیب (۶-۱۰ دلار در هکتار در سال) تخمین زده شد که بیانگر ۶۵ تا ۹۲ درصد کاهش ارزش علوفه تحت اشکال سنتی دامداری است. بنابراین، برای بهبود وضعیت مراتع و درآمد دامداری، نیاز به اجرای سیستم‌های چرایی مناسب احساس می‌شود.

کلمات کلیدی: اکوسیستم؛ چرا؛ قرق، ارزش اقتصادی؛ عشایری