Determining the Preference Value of Perennial Grasses Using Preference Index and Sheep Grazing Time Methods in Grasslands of the Middle Alborz, Iran

Saeed Rashvand, Hassan Yeganeh, Fazel Amiri

Abstract. Preference value means livestock preference to eat some plants relative to other plants or species. Accordingly, by studying the preference values, the range managers could determine the rangelands grazing capacity to achieve the optimum performance of livestock and to guarantee the stability of rangeland ecosystem. The objective of this study was to determine the preference value of perennial grasses using two methods of preference index (species feeding frequency) and sheep grazing time (feeding time recording) in a semi-steppe rangeland in the middle Alborz Mountains of Iran during four consecutive years (2010-2013). The collected data were tested for normality and then, analyzed by the software of SAS9.1. The means comparisons were made using the Duncan method. Results showed that sheep preferred five grass species (Bromus tomentellus, Festuca ovina, Dactylis glomerata, Agropyron intermedium, and Agropyron trichophorum) in the rangeland. There were significant differences between species and years for grazing time method; however, there were no significant differences for preference index. Also, there were significant differences between months within years for both methods. Results showed that A. trichophorum with the average value of 13.8% grazing time was ranked as the first species followed by D. glomerata with the average value of 11.1% as the second one (Grazing time method). There were no significant differences between A. trichophorum, B. tomentellus, D. glomerata and F. ovina regarding the preference index with the average values of 0.57, 0.75, 0.70 and 0.56, respectively. Overall, the results indicated that grazing time percent method in semi-arid rangelands gives more realistic results as compared to the preference index method because of the concrete and tangible results.

Key words: Preference value, Grazing time, Grazing capacity, Alborz mountain rangeland
Introduction

One of the basic principles of rangeland management is to determine grazing capacity to achieve the optimum performance of livestock and to manage the stability of range ecosystem (Galt et al., 2000; Meen, 2000). One of the most important factors in determining the grazing capacity is the preference values that means the livestock preferring to eat a specific plant to the others (Heady, 1964). The preference value is detected by two factors: the factor related to livestock and he one related to plant (Campbell et al., 2006; Ngwa et al., 2000; Bijanzadeh et al., 2010; Azadbar et al., 2011; Amiri et al., 2012).

Malechek and Provenza (1983) stated that when grasses are plentiful, goats do not graze all the parts of shrubs and select some parts with more nutritional value and also prefer a combined diet. Based on the study of plant compounds, Vallentine (2001) showed that the diet of sheep is composed of 2 to 23 percent of shoots, 9 to 62 percent of broad leaves and the remainder of narrow leaves, and reported a high variation in the diet of sheep. The percentage of usage and increasing need to forage for livestock, the estimation of rangeland capacity and pasture management are the components related to the estimation of dry matter consumption by livestock (Cordova et al., 1978; Vazquez and Smith, 2000). High forage consumption is estimated by livestock factors (physical, physiological, psychological and behavioral ones) and environmental factors (diet, climate and management). Some factors increase the consumption of forage by livestock or at least keep it in a high level and some other factors decrease the consumption of forage and primarily forage consumption is associated with several factors (Abdollahi et al., 2009; Amiri et al., 2014).

Erfanzadeh et al. (2014) investigated the preference values of plant species in three age classes of Kaboudeh sheep in rangelands of Bavanat, Fars. Sheep grazing times from different plant species were recorded using a Grazing Time method (chronometer). The results showed that the age of animals and plant species had significant effects on preference values of plant species and species of Poa pratensis and Avena fatua for young animals and Acer cinerascens for older ones had higher preference values. Ashouri Sanjabi et al. (2013) investigated the preference values of forage species of Tali goat in Chabahar rangelands of Iran during 2008-2010. To determine the preference value, time recorder method was used. Time of grazing of specific plant species by livestock was monthly recorded and analyzed during February to April. Results showed that the annual broad-leaved Launaea mucronata species had the highest preference value while two species of Sporobolus arabicus and Lottonis platycarpa had the lowest ones.

Ngwa et al. (2000) followed livestock 5 times for every herd and every 10 minutes to determine the preference values for sheep and goats, recorded the grazed species and estimated the grazing period of each species. Their study also showed that sheep spends two third of their time to graze grasses and goats spend most of their time to graze branches. The results also showed that Acacia seyal, Acacia sensegall, Pterocarpus lucens and Ziziphus mauritiana have high preference values. Hussain and Durrani (2009) by investigating the preference value of country rangelands concluded that sheep spent 54% of grazing time to forbs, 23% to grasses, 22% to shrubs and 1% to small trees, Also, goats spent 60% of grazing time to forbs, 27% to grass, 12% to shrubs and 1% to small trees. Rogosic et al. (2006) studied the Mediterranean shrubbery to compare the preference value of sheep and goats and observed
that goats ate more shrubs than sheep and also goats gained much weight in the region; therefore, goats should be kept in this area.

Mirdavoodi and Sanadgol (2009) investigated the preference value of rangeland species of Anjadan (Markazi province) by the grazing time method and concluded that palatable species in early grazing season were used highly by animals and during grazing, such species as Bromus tomentellus, Artemisia aucheri, As. glomerata, and Buffonia cf. koelzii were used by the utilization rates of 74, 43, 59 and 56 percent, respectively. Rashhtian et al. (2008) by determining the preference value of 7 for important rangeland species in steppe areas of Yazd province, Iran concluded that sheep spent much of their grazing time to Tragopogon, Artemisia and then to other annual plants with respect to the preference value in the rangeland species in different months of grazing season and its important role in determining the rangeland grazing capacity in order to achieve the optimum performance of livestock.

The aim of this study was to determine the preference value of rangeland species in the middle Alborz region, Iran using the preference index and the grazing time method. Accordingly, with the preference values, and the forage plants in rangeland management, the grazing capacity of rangelands can be determined to achieve the optimum performance of livestock and to guarantee the stability of rangeland ecosystem.

Materials and Methods
The Study Area
The study area is located in the middle Alborz mountain in 100 km North-East of Qhazvin with the longitude of 36º 21' N 50º 32' E, and altitude of 2400 m. Based on Dumarton coefficient, the climate is semiarid. According to the Embrothermic curve, five months of a year (June, July, August, September and October) are considered as the dry period (Fig. 1). The mean annual rainfall is 600 mm. Minimum, maximum and overall means of annual temperature are 12.5°C, 15.3°C and 13.8°C, respectively (Fig. 2).

The study area has mountainous physiographic types and Loamy soil. The vegetation landscape is grass-shrubbery. Vegetation types in the region include Agropyron intermedium and Astragalus microcephalus with 82 identified species in the floristic list. The main species include Festuca ovina, Astragalus microcephalus, Bromus tomentellus, Dactylis glomerata, Thymus kotschyanus, Poa bulbosa, Agropyron trichophorum, Agropyron intermedium, and Artemisia aucheri.
The Mixed breed livestock include 70% local, 20% Fashandi, and 10% Ghomi. Composition of livestock herds includes 30% goats and 70% sheep. The utilization system of this rangeland was rural and traditional. Growing season started from late April till the second half of September. Grazing period was determined from 25 May until the end of October for 155 days based on rangeland grazing permission.

Methodology
Preference value means livestock preference to eat a specific plant rather than the other plants and different species does not have the same preference in different growth stages. Accordingly, with preference value and forage plants in rangeland management, grazing capacity of rangelands can be determined to achieve the optimum performance of livestock (Becker and Lohrmann, 1992; Ngwa et al., 2000; Van Dyne et al., 1980). In this study, the Preference value was calculated by two methods.

Grazing Time Method
In this method, grass preference value was determined by a grazing time method (feeding minutes). During 2010 to 2013 in the middle of June, July, August and September, one to two hours after livestock entrance to rangeland, 20 minutes of livestock grazing in dominant flocks (3 year-old ewes of local race that was distinguished by color) were film recorded and grazing time of each species was specified after transferring to the computer. Then, species were arranged according to grazing time in each month in the descending order and their preference values were measured (Whittaker and Niering, 1975).

Preference index
Another method accomplished for determining the preference value was to determine the consumption percentage of the species; this method is called Preference index. In this method, after specifying five same stands of grasses for each grazing month, inside and outside of the enclosure were harvested in the late of each month; then, after the deduction of the gained forage outside from inside the enclosure, preference values of forage were calculated (Becker and Lohrmann, 1992). Table 1 shows the classification of palatability based on preference index. According to $P_{\text{index}}$ values, the class of palatability was determined (Van Dyne and Heady, 1965).

$$P_{\text{index}} = \frac{FD}{PRFs}$$  \hspace{1cm} (1)

Where:
$FD =$ forage ratio in the livestock diet, $PRFs =$ production ratio of the forage species.

These two parameters are determined as follows:

$$FD = \frac{Ps}{TPs} \times 100$$  \hspace{1cm} (2)

$$PRFs = \frac{Cs}{TCs} \times 100$$  \hspace{1cm} (3)

Where:
$Ps =$ production of each species in the month,$TPs =$ total production of the species in the month,$Cs =$ consumption of each species in the month,$TPs =$total consumption of the species in the month.

<table>
<thead>
<tr>
<th>$P_{\text{index}}$</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥2.1</td>
<td>The complete preference and highly palatable species</td>
</tr>
<tr>
<td>1.4-2</td>
<td>The relative preference and relative palatable species</td>
</tr>
<tr>
<td>0.7-1.3</td>
<td>The moderate preference and medium palatable species</td>
</tr>
<tr>
<td>0.3-0.6</td>
<td>The relative avoidance and almost non-palatable species</td>
</tr>
<tr>
<td>≤0.2</td>
<td>The complete avoidance and completely non-palatable species</td>
</tr>
</tbody>
</table>

Statistical Analysis
The data were tested for normality using Shapiro-Wilk statistic. Finally, the data were analyzed by the SAS software.
version 9.1. Data were combined over years using the split plot in time based on the completely randomized block design and the means were compared using the Duncan's Multiple Range Test at p<0.01.

Results

The Main Effects of Species, Month and Years

Results of means comparison of the species preference value of grass species are presented in Table 2. Results showed that *A. trichophorum* with the average value of 13.8% grazing time was ranked as the first one followed by *D. glomerata* with the average value of 11.1% as the second one. There were no significant differences between *A. trichophorum*, *B. tomentellus*, *D. glomerata* and *F. ovina* for preference index method with the average values of 0.57, 0.75, 0.70 and 0.56, respectively (Table 2).

In comparisons between months, higher and lower preference indices with the average values of 1.5 and 0.001 were observed in June and September, respectively. For grazing time percent, June and July with the average values of 9.56% and 9.06% were ranked as the first class as compared to two other months. There was no difference between two last months of the grazing season according to both methods (Table 3).

There was a significant difference between years for grazing time method but there was no difference between years for preference index. For grazing time method, 2012 had the highest grazing time percent and also there was no grazing time difference between 2011 and 2013 (Table 4).

### Table 2. Means comparison of the species preference value based on grazing time and preference index

<table>
<thead>
<tr>
<th>Species</th>
<th>Preference index</th>
<th>Grazing time method (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Agropyron trichophorum</em></td>
<td>0.567 a</td>
<td>13.81 a</td>
</tr>
<tr>
<td><em>Agropyron intermedium</em></td>
<td>0.306 b</td>
<td>1.90 c</td>
</tr>
<tr>
<td><em>Bromus tomentellus</em></td>
<td>0.707 a</td>
<td>6.86 c</td>
</tr>
<tr>
<td><em>Dactylis glomerata</em></td>
<td>0.759 a</td>
<td>11.10 b</td>
</tr>
<tr>
<td><em>Festuca ovina</em></td>
<td>0.56 ab</td>
<td>4.63 d</td>
</tr>
</tbody>
</table>

Means of columns followed by the same letters are not significant at p<0.05.

### Table 3. Means comparison of month preference value based on grazing time and preference index

<table>
<thead>
<tr>
<th>Month</th>
<th>Preference index</th>
<th>Grazing time percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>June</td>
<td>1.500 a</td>
<td>9.560 a</td>
</tr>
<tr>
<td>July</td>
<td>0.900 b</td>
<td>9.057 a</td>
</tr>
<tr>
<td>August</td>
<td>0.043 c</td>
<td>7.120 b</td>
</tr>
<tr>
<td>September</td>
<td>0.001 c</td>
<td>6.510 b</td>
</tr>
</tbody>
</table>

Means of columns followed by the same letters are not significant at p<0.05.

### Table 4. Means comparisons of years preference value based on grazing time and preference index

<table>
<thead>
<tr>
<th>Year</th>
<th>Preference index</th>
<th>Grazing time (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>0.47 a</td>
<td>5.95 c</td>
</tr>
<tr>
<td>2011</td>
<td>0.78 a</td>
<td>7.71 b</td>
</tr>
<tr>
<td>2012</td>
<td>0.56 a</td>
<td>9.45 a</td>
</tr>
<tr>
<td>2013</td>
<td>0.61 a</td>
<td>8.01 b</td>
</tr>
</tbody>
</table>

Means of columns followed by the same letters are not significant at p<0.05.

The Interaction Effects

The species × month interaction for preference index and grazing time method are shown in Figs. 3 and 4, respectively. There were significant differences between species reaction and months in both methods. All the species had the highest preference index in June and July and the lowest preference index was obtained in August and September (Fig. 3).
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Fig. 3. Means comparison of species × month interaction for preference index

Fig. 4. Means comparison of species × month interaction for grazing time percent method

Discussion
Considering the methods used in the recent study to determine the preference value of five grass species, the results of Table 2 showed that A. trichophorum was the dominant type in the study area and based on grazing time percent method, this species had the highest preference value as compared to other species. In contrast, A. intermedium had the lowest grazing time percent. The D. glomerata and B. tomentellus had the highest animal dietary preference based on preference index method and A. intermedium had the lowest value for both methods. A. trichophorum in the studied area was more abundant than other species; therefore, the estimation of its preference value based on grazing time method can be more preferable than preference index. This finding is validated by the finding of Abdullahi et al. (2009) stating that small distribution of species affected the consumption rate of plant. Other reports
indicated direct relationships between the plant availability and its selection as food (Springfield and Reynolds, 1951; Holechek et al., 1984; Malechek and Provenza, 1983; Aregheore et al., 2006). However, according to both methods, A. intermedium had the lowest palatability so that livestock had to graze this species because of loss of palatable species. Overall, species preference value changes were significant in the grazing time method whereas there were no significant differences for preference index. It is noteworthy mentioned that according to the grazing period (in this study from June to September), although there was no significant difference between the months of June and July in grazing time method, the highest and lowest grazing values were related to June and September, respectively. In fact, sheep may do their grazing mostly in June and July and near to the end of grazing months and available decreased forage, the amount of grazing pressure is reduced. Mirdavoodi and Sanadgol (2009) noted that the preference value of plant species is highly variable in different periods of grazing season and between different plant species. The results of the species and grazing season interaction showed that D. glomerata had the highest preference index in June whereas A. trichophorum was considered as the abundant species in the studied area. D. glomerata had the maximum value in June by grazing time method and it was noteworthy that A. intermedium had assigned to the lowest position of grazing value because of lower palatability by both methods. But this minimum value was observed in September for the preference index and in August and September for grazing time method. The reason for this discrepancy is due to the phenological and morphological forms of species. First, both Dactylis and B. tomentellus species started the vegetative phase earlier and produced more leaves than other species. Second, both species at the beginning of vegetative growth stage had wider and more brittle leaves than other species as livestock preferred both of them. In contrast, Festuca ovina at the beginning of vegetative stage had fibrous leaves than other species; this factor causes the changes in the animal preference. Regarding two other species of A. intermedium and A. trichophorum due to the grazing of their immature green spikes in July, the livestock preferred them more than previous months. Also, Ahmadi et al. (2009) in his study indicated significant differences of animal age, species and month interaction effects on preference index and the percentage of grazing time method. In both methods, the grazing pressure was reduced on perennial grasses in 2012 in presence of forb species, annual grasses, perennial forbs and perennial thorn-less Astragalus and livestock had diversity in grazing and abundance of species preference. In grazing time method, it is noticed that the grazing pressure decreased on available species in 2010 and the highest amount of grazing was related to 2012. In 2012, because of drought period and probably loss of these species, the value of grazing of these species was reduced. Our study showed the reduction of palatable species and also the reduced amount of forage at the end of grazing season. Also, local farmers were forced to bring folds inside the village from mid-July to prevent from the death of young livestock and reduction of their products but they kept the sheep being older than two years and more resistance to harsh conditions in the mountains until winter snow and cold pressure. In middle Alborz Mountain region, the departure of livestock from the rangeland occurs in early November and they move to lower elevations toward village and use farm pasture for the agricultural products. It was also shown that species composition and the amount of available forage to
livestock in rangeland are the main determining factors of plant preference by livestock. For example, the existence of palatable grasses next to annual and perennial forbs and shrubs in Alamut rangeland, Gazvin is very important and reduces the grazing pressure on this species.

Overall, the results showed that the preference value of species changes in different periods of grazing season and between different species in different years although this difference was not significant especially for years and species whereas the grazing time method was significant in all three investigated cases. Amiri et al. (2012) showed that there was no significant difference for preference value of species in sites, months and years whereas Ahmadi et al. (2009) showed that the preference value of each grazed species during different months was variable as our results confirmed it in our study. Grazing time method provides more realistic results than the preference index method because of being more concrete and tangible. Habibian et al. (2010) investigated both morsel counting and grazing time methods in the semi-stepped rangeland in Fars, Iran and stated that both methods had the same results. In this research, the grazing time method was recommended because of high accuracy, easy to do and repetition by computer operations despite longer time consuming and much cost as compared to morsel counting whereas Rashtian et al. (2008) preferred morsel counting method in comparison with that for grazing time method because of measurements with least means and equipment. They determined the preference value of seven important rangeland species in steppe areas of Yazd, which was done by grazing time and morsel counting.

**Conclusion**

Assessment of rangelands is an activity that frequently challenges those involved in the livestock industry, environmental protection, and land and rangeland management. Quantity and quality of available forage had some effects on feeding time and preference value by sheep. Grazing time method during a grazing season provides more acceptable results with regard to the preference value for perennial grasses. In this research, A. trichophorum and A. intermedium had the highest and lowest preference values based on two methods and other species were ranked as the middle ones.

**Reference**


تعیین ارزش رجحانی گراس‌های دائمی با استفاده از روش شاخص ارجحیت و میزان مصرف گوسفنده در گراس‌لدنهای البرز مرکزی ایران

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چکیده

ارزش رجحانی به معنی ترجیح دام برای خوردن بعضی گیاهان نسبت به گیاهان یا گونه‌های دیگر، می‌باشد. بر این اساس با مطالعه ارزش رجحانی، مدیران مرتع می‌توانند ظرفیت چرا مراتع را برای رسیدن به عملکرد مطلوب دام تعیین کنند که تضمین کننده پایداری اکوسیستم است. هدف از این مطالعه تعیین ارزش رجحانی گراس‌های دائمی با استفاده از روش شاخص ارجحیت و میزان مصرف گوسفنده در مراتع نیمه استپی در گراس‌لدنهای البرز مرکزی ایران در بازه زمانی ۰۴/۹۰ تا ۰۴/۹۳ به منظور دستیابی به عملکرد مطلوب دام و پایداری در استفاده از مراتع منطقه بود. ترجیح استفاده گوسلنده از جمله گراس‌های (Bromus tomentellus, Festuca ovina, Dactylis glomerata, Agropyron intermedium, Agropyron trichophorum) این گونه‌ها و سال‌ها تفاوت معنی‌داری داشت، اما در روش ارجحیت بین این دو روش تفاوت معنی‌داری مشاهد نشد. بر اساس نتایج گونه‌های D. glomerata به ترتیب با ۹۸/۹ و ۱۱۱/۳ درصد زمان مصرف دارای بالاترین ارزش رجحانی بر اساس روش B. tomentellus زمان مصرف بودند. بر اساس روش شاخص انتخاب اختلاف معنی‌داری بین گونه‌های مشاهده نشد و میانگین شاخص انتخاب آنها به ترتیب ۵۰/۲ و ۱۵۶/۰ بودند. به طور کلی، نتایج نشان داد که روش زمان مصرف در مرتع نیمه خشک نتایج واقعی‌تری را نسبت به روش ارزش رجحانی نشان داد.

کلمات کلیدی: ارزش رجحانی، زمان چرا، ظرفیت چرا، مرتع کوهستانی البرز