



## The impacts of *Atriplex* plantation from the viewpoint of stockholders

H. Niknahad-Gharmakher<sup>\*1</sup>, A. Sharifiyan-Bahraman<sup>2</sup>

<sup>1</sup>Assistant Professor, Department of Rangeland Management, College of Rangeland and Watershed Management, Gorgan University of Agricultural Sciences and Natural Resources, Gorgan, Iran

<sup>2</sup>Ph.D. Student, Department of Rangeland Management, College of Rangeland and Watershed Management, Gorgan University of Agricultural Sciences and Natural Resources, Gorgan, Iran

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### Abstract

*Atriplex* spp. (*Atriplex canescens*, *A. lentiformis* and *A. halimus*) plantation has been extensively used in order to reclaim rangeland in Iran in the past decades. However, the impacts of this technique has been a controversial issue and due to its increasing adoption, it is important to investigate its impacts in reclamation of degraded rangelands. The aim of this study was to investigate the viewpoints of stockholders in two winter rangelands in Golestan Province. First, the investigation factors were determined and then, using content analysis method, a questionnaire containing quintuple Likert, nominal and ordinal scale items as well as some open items was prepared and completed by stockholders. The number of samples was determined by Cochran formula. Data were analyzed through SPSS using descriptive statistics and Mann-Whitney test. The results revealed that the rangelands, livestock and forage production of *Atriplex* spp. play important roles in the life and livelihood of stockholders of both studied areas. Considering all investigated items, in majority of cases the desirable effects of *Atriplex* spp. plantation was dominant in the viewpoints of Ghareh-Doung stockholders. The results indicated that despite some differences, the stockholders are satisfied with *Atriplex* spp. plantation in the two studied areas. More investigation on the effects of *Atriplex* spp. on the dairy and meat production was proposed.

**Keywords:** Rangeland reclamation, *Atriplex* spp., Stockholders, Golestan Province.

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\* Corresponding author; hamidniknahad@yahoo.com

## Introduction

Rangelands are the main vegetation cover of Iran due to low and scattered precipitation, which is characteristic of the Mediterranean climate (Eskandari *et al.*, 2008). Rangelands are the main source of meat and dairy products and a considerable number of populations of Iran depends on them economically (Kamalzadeh and Kiasat, 2008).

It is important to apply a range management technique for the highest utilization with the lowest damage in order to save these valuable resources for future generations. However, overgrazing of rangelands has decreased their production dramatically. Hence, there is a need to improve rangeland production. This has been implemented using seed sowing and seedling plantation of range species successfully which made the balance between the number of livestock and forage production in some regions. Selection of suitable plants regarding the ecological condition of a specific region is the most critical decision in this management process. For example, shrub species are appropriate plants for areas with limited precipitation due to their biological capabilities. These plants have an important role in preventing rangeland degradation. In addition, they produce enough forage especially during dry season when forage production of grass and forbs is low (Pengelly *et al.*, 2003, FAO, 1995).

Halophyte shrub species, which are of the genus *Atriplex spp.*, have been used for rangeland rehabilitation and animal feeding in central Asian countries (Hyder and Akil, 1987). These plants grow in areas with 200 to 400 mm annual rainfall (le Houerou, 1992). Halophytic plants have high tolerance to soil salinity

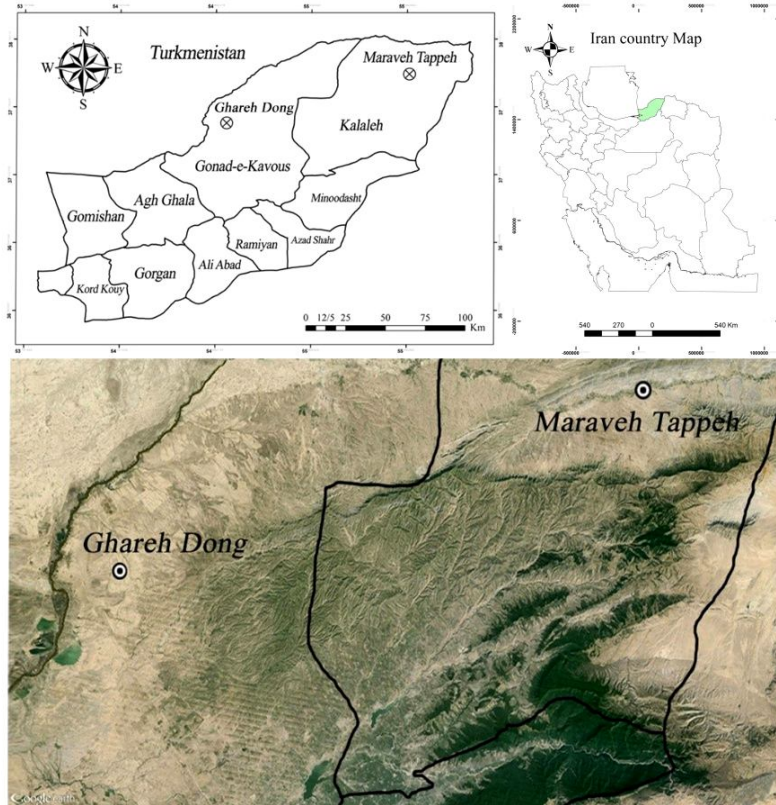
(Papanastasis *et al.*, 2008) and alkalinity (Jafari, 1994) which are characteristics of semi-arid regions. Tolerance of these halophyte shrubs to harsh conditions of the semi-arid areas makes them the best plant for improving rangelands of these regions.

Overgrazing has degraded rangelands of Iran specifically in the semi-arid regions. In this regard, different species of *Atriplex spp* (*Atriplex canescens*, *A. lentiformis* and *A. halimus*) have been planted widely in order to improve rangelands condition over the past decades (Hente *et al.*, 2008).

Although this improvement technique is suitable from some aspects, its effect on rangeland condition and livestock production needs to be evaluated. Since these plants are non-native, it is important to investigate their plantation on rangelands as a new introduced species. Several studies have been conducted to reveal the effects of *Atriplex spp.* plantation on soil properties and plant characteristics in Iran (Chalakhaghghi, 2000; Khalkhali, 1996; Hente, 2003), but only one study has focused on stockholders and their opinion regarding this plantation (Hente *et al.*, 2008). So, this study aimed to investigate the impacts of rangeland improvement practices through *Atriplex spp.* plantation technique in Golestan Province, Iran.

## Materials and Methods

This research was performed in winter of 2014. The study areas were Maraveh – Tappeh and Ghareh-Doung in the east of the Golestan Province, Iran (Figure 1).



**Figure 1.** Location map showing the case study rangelands in northern Golestan Province, Iran.

This region has two distinct seasons. Rainy season starts from mid-November to May and the dry season from mid-May to October (Table 1).

We obtained information from individual interviews and classified it using content analysis method and then a questionnaire containing quintuple Likert, nominal scale and ordinal scale items as well as some open items was prepared. The validity of the questionnaire items was approved by experts and to find the reliability of the questionnaire, a number of them were completed by stockholders. Cronbach's alpha coefficient was obtained for all

studied items and showed a favorable rate (>0.7) by removing some questions with poor coefficient. Finally, the refined questionnaires were completed by stockholders. The number of samples (58 samples) was determined by Cochran (1977) formula:

$$\text{Equation (1)} \quad n = \frac{N(t.s)^2}{Nd^2 + (t.s)^2}$$

where  $n$  is sample size,  $s$  is standard deviation,  $N$  is population size,  $d$  and  $t$  is the desired level of precision and  $t$  is  $t$ -value at 0.95 probability level.

**Table 1.** Environmental characteristics of rangeland exclosures in the study area.

Study area	Latitude	Longitude	Mean annual rainfall (mm)	Mean annual Temperature (°C)	Climate	Altitude (m)
Ghareh-Doung	37° 39' N	54° 57' E	250	17.6	Semi-desert	82
Maraveh-Tappeh	37° 46' N	55° 52' E	482	16.7	Cold-Semiarid	620

The data were analyzed through SPSSver21 using descriptive statistics (frequency and relative frequency) and Mann-Whitney test.

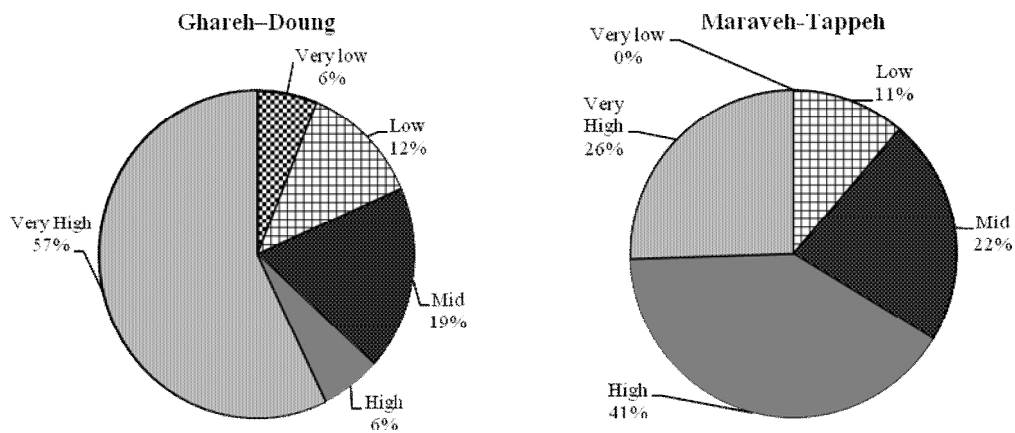
**Results**

***The viewpoint of two groups about role of rangeland, livestock and Atriplex spp. production on livelihood of stockholders***

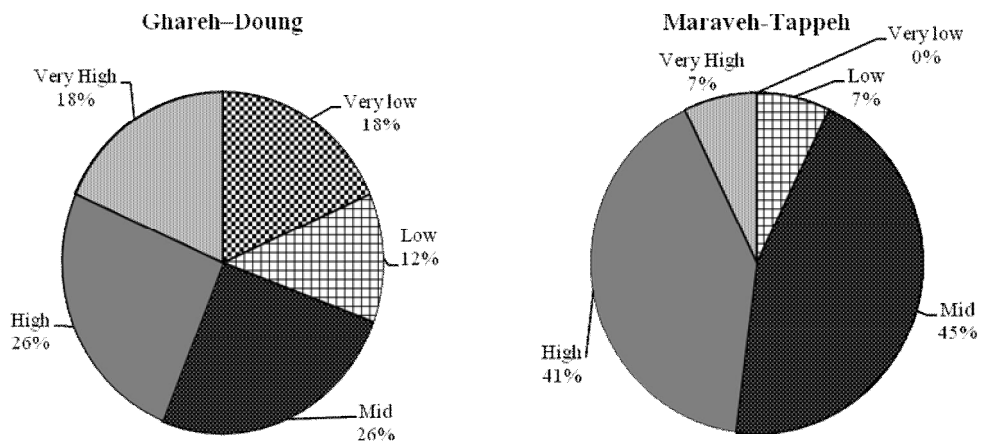
Firstly, the importance of livestock in the livelihood and income of stockholders was investigated (Figure 2). According to the results, 63% of Ghareh-Doung and 67% of Maraveh-Tappreh stockholders believed

that their income are highly dependent on livestock.

This research studied what portion of daily livestock’s forage obtained from rangeland. As found, this is 93% in Maraveh-Tappeh and 70% in Ghareh-Doung (Figure 3). Then we investigated what portion of livestock’s forage need was acquired from *Atriplex spp.* specifically. The stated level of dependency of livestock’s daily need to *Atriplex*’s forage was 82% and 70% for Ghareh-Doung and Maraveh-Tappeh, respectively (Figure 4). Results of this study shows *Atriplex spp.* plantation.



**Figure 2.** The role of pastoralism in the livelihood and income of exploiters.



**Figure 3.** The role of rangeland in supplying of livestock’s daily requirement for exploiters.

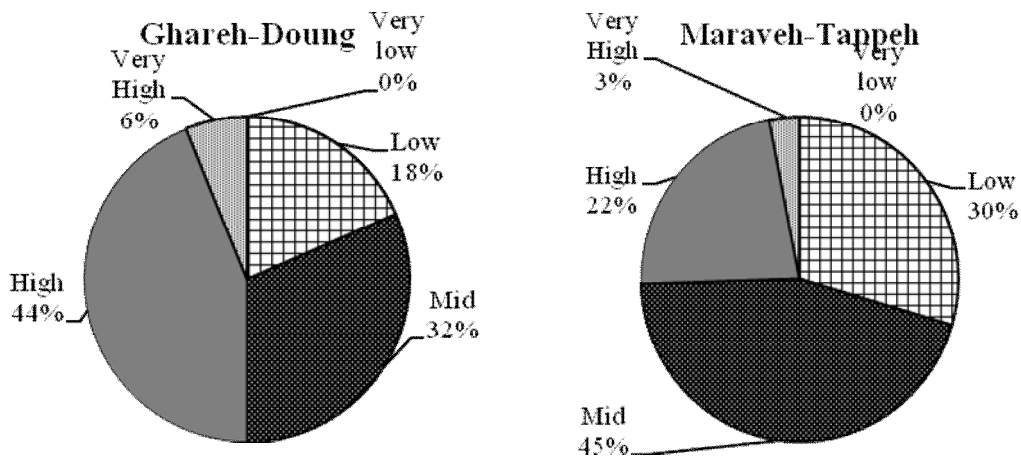


Figure 4. The role of Atriplex's forage in supplying of livestock's daily requirement.

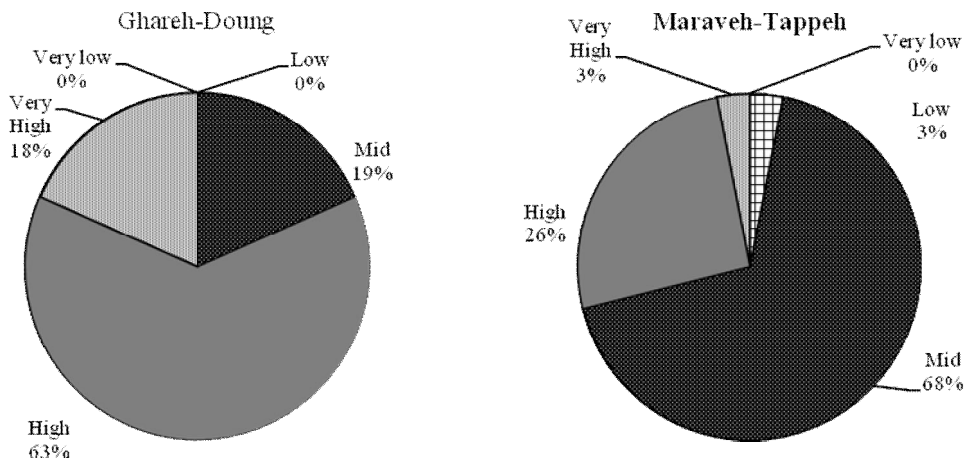


Figure 5. Atriplex plantation's impact on increasing of rangeland's vegetation cover.

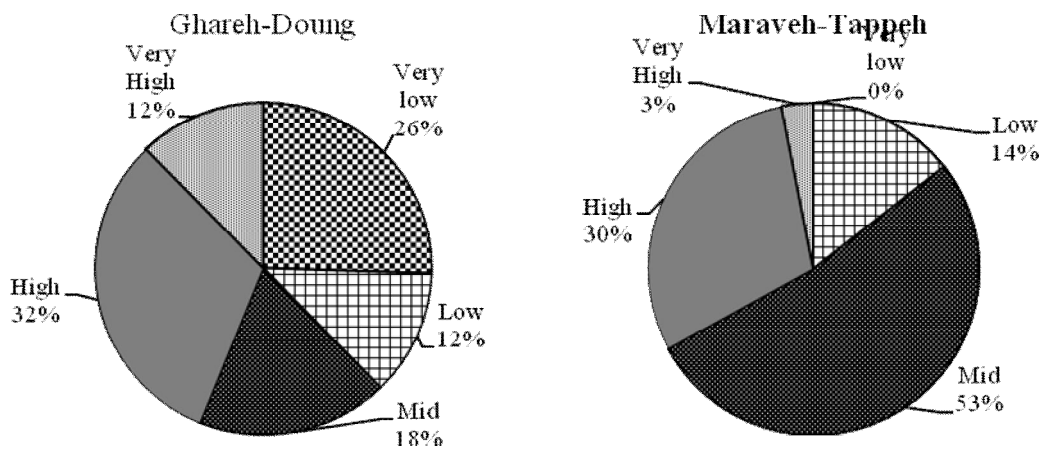


Figure 6. Atriplex plantation's impact on increasing of grazing period.

Has more effect on the increasing of vegetation cover than increasing of period of exploitation (Figures 5 and 6).

The results (Figures 2, 3, 4, 5 and 6) demonstrated that except the item "the effect of *Atriplex spp.* plantation on increasing the rangeland vegetation cover", there is no significant difference ( $P < 0.05$ ) in all investigated items between viewpoint of stockholders of the two studied areas.

#### **The viewpoints of the two groups about *Atriplex spp.* plantation**

According to the results (Table 2), there was a significant difference in many studied

items in terms of averages. From the viewpoint of Ghareh-Doung stockholders, *Atriplex* had 100% satisfactory growth, while this item for Maraveh-Tappeh stockholders was 70%. In fact, for all of the studied items, except items 5, 7, 8 and 10, there were significant differences between the two groups ( $P > 0.05$ ). Investigation of question 11 "*Atriplex spp.* plantation is known in the region to be useful" demonstrated that usefulness of *Atriplex spp.* plantation in the viewpoint of Ghareh-Doung stockholders was relatively higher than those of the Maraveh-Tappeh stockholders.

**Table 2.** Frequency percentage and comparison of viewpoints between the two groups of respondents about *Atriplex spp.* plantation.

Row	Question	Maraveh-Tappeh (%)		Ghareh-Doung (%)		P value
		Yes	No	Yes	No	
1	Acceptable plant growth after plantation	77	23	100	0	0.045*
2	Awareness of advantages and disadvantages for the exploiters	29	71	100	0	0.000**
3	Reduction in amount of hand feeding due to <i>Atriplex spp.</i> plantation	49	51	82	18	0.034*
4	Increasing of Livestock's health care costs because of <i>Atriplex spp.</i> consumption	11	89	37	63	0.042*
5	Willingness to participate in continuation of the plantation by exploiters	59	41	87	13	0.054 <sup>ns</sup>
6	Reduction in flood's damage because of <i>Atriplex spp.</i> plantation	56	44	94	6	0.009**
7	Exploiters' agreement with protection of cultivated pastures	25	75	43	57	0.233
8	Reduction of the periods of protection in cultivated pastures	77	23	68	32	0.517
9	<i>Atriplex spp.</i> is affected by drought and destroyed by that	71	29	37	63	0.037*
10	Changes in the composition of herds' livestock due to plantation of <i>Atriplex spp.</i>	33	67	57	43	0.146
11	<i>Atriplex spp.</i> plantation is known in the region to be useful	66	34	94	6	0.045*
12	Willingness to continue the process of <i>Atriplex spp.</i> plantation by exploiters	59	41	94	6	0.016*

\*, \*\* Significant at 5% and 1% probability levels, respectively.

#### **The viewpoints of two groups about the benefit of *Atriplex spp.* plantation**

The effects of *Atriplex spp.* plantation on ecological, environmental, economic and animal grazing factors were investigated

(Table 3). According to the results, for most studied factors, there is a significant difference between viewpoints of stockholders of the two studied areas.

Despite the high percentage of the viewpoints of stockholders in “no change” section, the percentage of their viewpoint for “increase” and “decrease” sections for some investigated factors are considerable. Stockholders viewpoints to “trend of native plants change”, “quantity of livestock”, “per household’s income”, “termite population”, “mice and other rodents population”, “animal diseases”, “fauna (snakes, jackals, wolves, etc.)”, “livestock water requirements”,

“period of rangeland’s exploitation” and “trend to graze livestock in the rangeland” items showed considerable level of increase or decrease in the two studied areas and have large differences in some cases, as well.

The result of the last investigated item of this section “*Atriplex spp.* plantation trend in future” demonstrated that there was a growing desire to increase *Atriplex spp.* plantation in both of the two studied areas.

**Table 3.** Frequency percentage and comparison of viewpoints of two groups of respondents about the benefit of *Atriplex spp.* plantation.

Row	Question	Maraveh-Tappeh (%)			Ghareh-Doung (%)			P value
		Decrease	Increase	No change	Decrease	Increase	No change	
1	Trend of native plants change	38	7	55	12	68	18	0.000**
2	Forage production in cultivated pastures	29	29	42	19	0	81	0.034*
3	Forage quality changes	29	12	59	6	0	94	0.019*
4	Trend of meat and dairy products	5	14	81	0	0	100	0.071
5	Quantity of livestock	12	11	78	7	25	68	0.000**
6	The weight of each livestock	12	11	78	0	25	75	0.789
7	Household income	4	30	66	0	25	75	0.000**
8	Termite population	11	19	70	0	87	13	0.003**
9	Mice and other rodents’ population	0	63	37	0	100	0	0.006**
10	Animal diseases	8	29	63	43	7	50	0.000**
11	Fauna (snakes, jackals, wolves, etc.)	0	34	66	0	75	25	0.009**
12	Livestock water requirements	7	49	44	62	32	6	0.000**
13	Period of rangeland’s exploitation	30	15	55	31	56	13	0.073
14	Trend to graze livestock in the rangeland	23	29	48	0	93	7	0.000**
15	The use of other rangeland forage	26	14	59	12	18	68	0.000**
16	<i>Atriplex spp.</i> plantation trend in future	14	57	29	6	76	18	0.000**

\*, \*\* Significant at 5% and 1% probability levels, respectively.

#### ***The viewpoints of the two groups about other aspects of Atriplex plantation***

According to the results (Table 4), there is significant difference ( $P > 0.05$ ) between the viewpoints of the two studied areas except “potential for plantation of forage species other than *Atriplex spp.*” item.

Considering positive and negative answers to the investigated items, stockholders of both study areas are interested to use other plant species besides *Atriplex spp.* It was found that *Atriplex spp.* plantation has changed soil properties, as well.

**Table 4.** Frequency percentage and comparison of viewpoints between the two groups of respondents about some consequences of *Atriplex spp.*

Row	Aspect of <i>Atriplex spp.</i> using	Maraveh-Tappeh (%)		Ghareh-Doung (%)		P value
		Yes	No	Yes	No	
1	Differences in <i>Atriplex spp.</i> consumption during drought and wet years	86.0	14.0	31.0	69.0	0.000**
2	Potential for the cultivation of forage species other than <i>Atriplex spp.</i>	81.0	19.0	81.0	19.0	0.985 <sup>ns</sup>
3	Changes in the composition of herds' livestock due to growing of <i>Atriplex spp.</i>	26.0	74.1	68.0	32.0	0.007**
4	There are other uses for <i>Atriplex spp.</i> apart from forage	3.0	97.0	32.0	68.0	0.013*
5	Changes in soil properties because of <i>Atriplex spp.</i> cultivation	33.0	67.0	93.0	7.0	0.009**
6	Decrease in participation in cultivation due to common exploitation systems	71.0	29.0	19.0	81.0	0.001**
7	The trend of destruction for <i>Atriplex spp.</i> in region	0	100.0	62.0	38.0	0.001**

\*, \*\* Significant at 5% and 1% probability levels, respectively.

## Discussion

The results of this study in various sectors of importance, aspects and effects of *Atriplex spp.* plantation items have two general conclusions. First, general description of *Atriplex spp.* plantation situation in both studied areas. Second, comparison of the two studied areas in terms of *Atriplex spp.* plantation status. The results demonstrated that the rangelands, livestock and forage of *Atriplex spp.* play an important role in the life and livelihood of stockholders of both studied areas (Figures 2, 3, 4, 5 and 6). The effects of *Atriplex spp.* plantation on increased vegetation cover which consequently increased grazing period was revealed, as well. These results are in agreement with the results of Hente *et al.* (2008) and Chisci *et al.* (2001). In general, satisfaction of the stockholders of Ghareh-Doung area was higher than Maraveh-Tappeh regarding *Atriplex spp.* plantation. Considering all investigated items, in the majority of cases there was agreement on the desired effects of *Atriplex spp.* The plantation was observed more desirable in the viewpoints of Ghareh-Doung stockholders compared to Maraveh-Tappeh area.

The obtained results about "acceptable plant growth after plantation" and "*Atriplex spp.* affected by drought and destroyed by it" items for Maraveh-Tappeh area are the same and can explain the low utility of *Atriplex spp.* plantation in this area. Studies have demonstrated that *Atriplex spp.* production efficiency is reduced during the drought (Milton *et al.*, 1995). Although it must be considered that the utility of *Atriplex spp.* during the drought is because of the lack of other forage species.

The third section of this investigation revealed that the items related to trend of native plants changes, quantity and quality of livestock, the weight of individual livestock, household income, termite population, mice and other rodents' population, period of rangeland's exploitation and trend to graze livestock in the rangeland have been highly increased in the Ghareh-doung rangelands after *Atriplex spp.* plantation. The trend of the change in the native plants in Ghareh-Doung rangelands was positive while it was negative for Maraveh-Tappeh. These results are in agreement with the results of Hente, *et al.* (2008). They reported that *Atriplex spp.* plantation led to



increasing native plants population because of rangeland enclosure after plantation.

*Atriplex* in combination with other species can improve some soil properties in favor of native plants. Chisci *et al.* (2001) found that *Atriplex spp.* plantation with a legume called Sulla (*Hedysarum coronarium*) improved soil stability and porosity which consequently decreased soil erodibility and floods. This provides a suitable condition for increasing plant population and their growth rates. This could lead to livestock weight gain and household income improvement.

The increase of termite's population, found in the Ghareh-Doung rangelands, was because of their high attraction to salt and their needs to fiber which is provided by halophyte shrubs such as *Atriplex sp.* (Crist, 1998). It should be noted that the presence of termites in ecosystems is very useful. Termites help turn over the organic materials to the soil (White *et al.*, 1996), which improves soil properties. Termites provide plants nutrients by transferring dead materials from surface layer around plants root (MacKay, 1986). Small mammals such as rat are directly dependent on the vegetation sources for food supply and nesting (Zwolak *et al.*, 2012). Therefore, the considerable increase of their population, 100% in Ghareh-Doung and 63% in Maraveh-Tappeh, is not surprising. The presence of woody species remarkably increases abundance, distribution and presence of small mammals (Horncastle *et al.*, 2005) which is the reason of improving fauna of the study areas that has been reported in the present study. These results are in agreement with the results of Hente *et al.* (2008).

According to the viewpoints of Ghareh-Doung stockholders, plantation of *Atriplex spp.* has led to an increase in the presence of camel in herd composition but such result was not observed in Maraveh-Tappeh. In Maraveh-Tappeh, EC of the soil is low and therefore, *Atriplex spp.* is a useful forage for sheep and cattle. The dominant livestock are sheep, cows and goats. Camels are in the last place. The

main consumers of *Atriplex spp.* forage in Syria are goats, sheep and camels (Tadros, 2000; Murad, 2000). In Ghareh-Doung rangelands, the EC of soil is high and because of adaptability of *Atriplex spp.* with soil salinity, the forage of *Atriplex spp.* has higher salt compared to Maraveh-Tappeh. Based on the results of the present study, diarrhea in livestock was reported as a disease caused by *Atriplex spp.* that is in agreement with the results of Hente *et al.* (2008). The positive effects of *Atriplex spp.* consumption on the livestock reproduction and twinning was stated by many of Ghareh-Doung rangeland stockholders that was not the case in Maraveh-Tappeh. These results are in contrast with those of Hente *et al.* (2008). They stated that *Atriplex spp.* consumption leads to a decrease in pregnancy and increased abortion in livestock. In the Mediterranean areas, some studies focused on the effects of *Atriplex spp.* consumption on biological characteristics of livestock. Studying the impact of feeding saltbush (*Atriplex spp.*) on some mineral concentrations in the blood serum of lactating Awassi ewes by Alazzeah and Abu-Zanat (2004) demonstrated that feeding saltbush causes increase in Ca and decrease in P, Mo and Mn in ewes' blood. The amount of selenium in animals fed by these plants exceeded the normal rate. The researches demonstrated that livestock feeding on *Atriplex* caused changes in quantity and quality of their milk (Goodchild *et al.*, 1997). Increasing consumption of *Atriplex amnicola* in diet of the goat has led to a significant reduction of goat milk production in Pakistan (Raza *et al.*, 2000).

### Conclusion

The present study indicated that despite some differences, the stockholders are satisfied with *Atriplex spp.* plantation in both of the studied areas. Investigation on the effects of *Atriplex spp.* on milk production and growth of the lambs as the main source of income to stockholders (Abu-Zanat and Tabbaa, 2006) is proposed.

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