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The Effect of Type of Marginal Land Use on the Production of Biomass and Plant Diversity

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Abstract: The objective of this study closely focuses on the settlement of the effect of marginal land use on plant diversity. The location of this study was Sar Firouze Abad region with rainfall of over 350 mm and slope of over 12%. Five treatments in terms of land use (exclusion area, grazed range, fallow, annual medic cultivation, wheat cultivation) done with the repetition of five times. The factors, such as the number of species, the number of plant bases in each species, the percentage of plant cover and biomass in each sampling were measured. The method used here is based upon complete randomized design applying Duncan test and Raunkiaer method for classification of plant species and also Shannon's diversity index of diversity and homogeny utilized. The results show that there are 76 species belonging to 60 genus and 19 families spreading in the region under study. The most dominant families are Fabaceae with 15 species covering 20% and Poaceae with 13 species covering 17%, respectively. According to Raunkiaer method the life form of the region species can be classified as Therophytes 66%, Geophytes 3%, Hemicryptophytes 26% and Chamaephytes 5%. The results also illustrate that the treatment of exclusion area has the most plant diversity, the percentage of plant cover and biomass in comparison with the rest of treatment cultivation and range grazed.

Key words: Land use, marginal lands, diversity, biomass, Duncan test, Raunkiaer method and Shannon's diversity index

INTRODUCTION

The nourishing security is considered as an international issue which focuses on people's right to access freely to sufficient food in order to conduct an active and healthy life in all over the world equally. To have sustainable agriculture nourishing security, it should be kept in mind that the biological protection of plant diversity is regarded as one of the most important instruments for agricultural development. The excessive growth in farming of marginal lands causes a destructive damage to soil and also affects the diversity and abundance of plants. Nowadays, researchers regard rangelands primarily as a main genetic bank. Sustainable bio-diversity proves to be the main objective in this regard and it insists on the fact that living things diversity should be preserved in possible ways. The change of rangelands into rain feed lands demonstrates the destructive interference of man in natural ecosystems led to the erosion of soil and cover and plant diversity. These lands called marginal lands which are in fact buffer regions. They protect main regions or rangelands like battlements. The establishment of permanent residence by man and his cattle in these regions destroyed the natural cover and increased the number of species bread by him. The relationship between variety and sustainability has arisen a lot of discussions among researchers (Ma, 1970, 1981; Goodman, 1975; Jacobs, 1975; Margalef, 1975; Van der Maarel, 1988, 1990). Many ecologists maintain that the highs richness of species is viewed as one of the most favorable features in every society or ecosystem. This feature is of high significance in evaluating the methods concerning the issue of protection of nature (Usher, 1986).

Whittaker (1965) was the first researcher who put forward the issue of diversity in 1965. He analyzed and calculated diversity in terms of species combination. In order to measure diversity many factors has been used invented, but perhaps the total number of species under the name of richness of species is much more well-known (Magurran, 1988).

Naimi (2004) used satellite information in order to evaluate plant diversity in Golestan National Park. He shoed that plant diversity factor is the most effective one in analyzing floristic diversity. Bai *et al*. (2001) investigated relationship between plant species diversity and grassland condition. The results of this study show that the Shannon's diversity index followed a curvi-linear relationship with range condition, increasing from fair to good, but decreasing from good to excellent condition, within a range between 0.66 and 2.58 species evenness was affected by range condition in a similar manner ranging from 0.44 to 0.86. the Shannon's diversity index was positively correlated with forb biomass, but not with biomass of any other group or their combination. Sharifie Niarag (1996) performed a research on determining diversity and the richness of species and classification of meadow. He made use of Whittaker method and cluster analysis. He showed that diversity of plant cover observed more in grasslands. Sharifie Niarag and Iemanie (2006) studied change of the species composition and canopy covering following firing operation and while using Quadrate and Transects studied before. The result indicated shrubs had been reduced from 24.81 to 2%, but perennial grasses increased from 51.97 to 80.63%. Ghlichnia (2006) did a comparative study of variety and production of plant cover bath in and of out of Robat Garabil of Golestan National Park. The study carried out in key, critical and reference regions whose Topographical, soil and climate conditions were nearly the same. He maintained that the excessive grazing in critical region made diversity and product poor while in key region due to moderate grazing, is Reich and in reference region due to lack of grazing plant diversity is poor but product is rich regarding the rest of regions. The Planning and Budgeting Organization (2006) carried out a study on the cause of destruction on Chahar tang-e- Koshk-e-zar wetland.

The study revealed that the cause of destruction of this ecosystem was due to the change of rich rangelands into farming lands and also excavation for supply of water for irrigation purpose. This change in land use made both rich flour of the region and plant diversity destroy. The destruction of plant diversity caused the bio-diversity of the region where was once a hunting-ground to vanish. So a serious damage was done to sustainable development of the region. Sprugel (1991) studied the human effect on plant environment and the aftermath of land use change. He demonstrated that all of these effects on plant diversity were negative and damaging. Otte (2005) made models of plant diversity and richness in farming lands, grasslands and wetland using GIS. Her model reveals the significance of diversity and richness in ecosystems in terms of economic management of these lands. Sara and Cousins (2005) carried out a research in Sweden and showed that the growth and variety of plants of rangelands and grasslands managed in traditional ways are 23% more than lands under mechanized management.

Eycott (2006) illustrated that one of the factors of sustainability in forests is plant diversity in these lands which means a positive sequence. So plant diversity is essential to sustainability of a ecosystem. It should be noted that habitations of village margins and margins of farming lands (marginal lands) can play a vital role in enriching and development of various species of plants. But there is a little in formation on how such habitations can effect on plant species. The issue of sustainable development in agriculture together with the preservation of diversity and genetic bank in lands changed in land use and also the study of the effects of such uses is the object of this study.

MATERIALS AND METHODS

This study performed in Sarfirouze Abad rangelands in Kermanshah province with geographical latitude 47° and 6', longitude 34° and 15', rainfall over 350 mm, altitude 1542 m and sleep 12%. The texture of soil is loamy-clay. five treatments in terms of the type of use including: exclosure graze land (evidence), rangeland under grazing, fallow, medic cultivation, wheat cultivation with repetition of five times were used in farming year of 2005-2006. The least essential samples number and sample size for vegetations cover measurements in each site was calculated by the following Eq. 1 (Bonham, 1989).

$$N = \frac{t^2 \times s^2}{(\bar{x} \times k)^2} \quad (1)$$

Where:

N = No. of essential samples
t = t student value with n-1 and ∞ = 5%
s = Standard variation
$\bar{x}$ = Mean vegetation cover
N = primary sample number
k = Precision coefficient (10%)

In each plot, factors such as: the number of plant density, the number of species, the percentage of cover and biomass were measured by harvested method (cut and weight method). The results of this study are analyzed by SPSS computer program and LSD analysis and Duncan test. The formulas for plant diversity used here are:

$$J = \frac{H'}{H'_{max}} = \frac{\sum_{i=1}^{s} PiLnPi}{LnS} \quad (2)$$

$$H' = -\sum_{i=1}^{s} PiLnPi \quad (3)$$

Here, Pi is the ratio of one species to all, LnPi log of species ratio and S is the total number of species. In the Shannon's diversity index the bigger number, the more diversity and the bigger values of J demonstrate that the distribution of species is more consistent in the frame. So we can conclude that it a satisfactory evidence for the suitable propagation of plant species.

Table 1: The Floristic list of plant species observed in the geographical region under study

Families	Scientific name	Row	Families	Scientific name	Row
Fabaceae	*Astragalus cruciatus*	39	Poaceae	*Henrardia persica*	1
Fabaceae	*Astragalus kohrudicus*	40	Poaceae	*Hordeum bulbosm*	2
Ranunculaceae	*Consolida oliveriana*	41	Poaceae	*Lolium* sp.	3
Ranunculaceae	*Aquilegia olympica*	42	Poaceae	*Parapholis incurva*	4
Ranunculaceae	*Adomis flammea*	43	Poaceae	*Poa bulbosa*	5
Ranunculaceae	*Ranunculus lingua*	44	Poaceae	*Taeniatherum crinitum*	6
Ranunculaceae	*Nigella* sp.	45	Poaceae	*Heterantlium* sp.	7
Euphorbiaceae	*Euphorbia helioscopia*	46	Poaceae	*Bromus* sp.	8
Euphorbiaceae	*Euphorbia* sp.	47	Poaceae	*Bromus* sp.	9
Euphorbiaceae	*Euphorbia virgata*	48	Poaceae	*Bromus tectprum*	10
Euphorbiaceae	*Euphorbia falcata*	49	Poaceae	*Bromus dantonia*	11
Boraginaceae	*Onosma macrophyllum*	50	Poaceae	*Agropyrum* sp.	12
Boraginaceae	*Onosma bulbotrichum*	51	Poaceae	*Stipa barbata*	13
Boraginaceae	*Nonnea caspica*	52	Compositae	*Chardinia orientalis*	14
Lamiaceae	*Phlomis oliviri*	53	Compositae	*Senesio vernalis*	15
Lamiaceae	*Stachys inflata*	54	Compositae	*Taraxacum* sp.	16
Lamiaceae	*Ziziphora* sp.	55	Compositae	*Echinops persicus*	17
Lamiaceae	*Salvia staminea*	56	Compositae	*Echinops orientalis*	18
Caryophyllaceae	*Cerastium* sp.	57	Compositae	*Carthamus oxyacantha*	19
Convolvulaceae	*Convulvolus arveusis*	58	Compositae	*Lasiopogon muscoide*	20
Caryophyllaceae	*Vacaria pyramidata*	59	Compositae	*Xeranthemum squarrosum*	21
Caryophyllaceae	*Minuartia meyeri*	60	Compositae	*Tragopogon* sp.	22
Caryophyllaceae	*Silen conoidae*	61	Compositae	*Antemis* sp.	23
Geraniaceae	*Geranium tuberosum*	62	Compositae	*Crupina crupinastrum*	24
Geraniaceae	*Erodium oxyrrhnchnm*	63	Compositae	*Scariola orientalis*	25
Malvaceae	*Alcea tehranica*	64	Fabaceae	*Vicia michauxii*	26
Malvaceae	*Malva parviflora*	65	Fabaceae	*Vicia villosa*	27
Apiaceae	*Cancalis platycarpns*	66	Fabaceae	*Vicia ervilia*	28
Apiaceae	*Eryngium caeruleum*	67	Fabaceae	*Medicago polymorpha*	29
Apiaceae	*Torilis arvensis*	68	Fabaceae	*Medicago scutelata*	30
Crucifereae	*Conringia orientalis*	69	Fabaceae	*Medicago radiate*	31
Papaveraceae	*Papaver gaubae*	70	Fabaceae	*Trifolium* sp.	32
Primulaceae	*Androsace* sp.	71	Fabaceae	*Trifolium* sp.	33
Brassicaceae	*Lepidium perfoliatum*	72	Fabaceae	*Lathyrus* sp.	34
Dipsacaceae	*Scabiosa olivieri*	73	Fabaceae	*Pisum sativum*	35
Iridaceae	*Gladiolus atroviolacens*	74	Fabaceae	*Trigonella monatha*	36
Asteraceae	*Gundelia tonrnefortii*	75	Fabaceae	*Astragalus gossypinus*	37
Rubiaceae	*Galium* sp.	76	Fabaceae	*Astragalus cordatus*	38

RESULTS

The results demonstrated that there were total 76 species belonging to 60 genera and 19 families in the geographical region under study (Table 1). The richest families are Fabaceae with 15 species (20%) and Poaceae with 13 species (17%), repetitively. Out of total number of existing species in the region under study, 10% belong to Fabaceae family and sixteen percent belongs to Poaceae family. With regard to abundance of genera and species, the other plant families are Compositae, Ranunculaceae, Caryophyllaceae, Euphorbiaceae, Lamiaceae, Boraginaceae and Apiaceae, respectively (Table 2). Plant species of the region can be classified with accordance to live form and Ranicar method as 66% Therophytes, 3% Geophytes, 26% Hemicryptophytes and 5% Chamaephytes (Table 3). Duncan test showed that there was a significant difference between treatments at the level of 1%. This occurred due to the number of plant (Table 4). The exclosure treatment had the maximum number of plant. There was also a significant difference between treatments at the level of 1% regarding

Table 2: Number of different families' species

Families	Percent of families
Poaceae	17.0
Compositae	15.0
Fabaceae	20.0
Ranunculaceae	6.5
Euphorbiaceae	5.1
Boraginaceae	4.2
Lamiaceae	5.0
Caryophyllaceae	6.4
Gelaniaceae	3.2
Malvaceae	2.8
Apiaceae	3.8
Cruciferaceae	1.7
Papaveraceae	1.6
Primulaceae	1.6
Brassicaceae	1.6
Dipsaceace	1.4
Iridaceae	1.6
Asteraceae	1.5

Table 3: Percent of life form plants based on Rankayer method

Life form	Percent of plant
Therophytes	66
Hemicryptophytes	26
Chamaephytes	5
Geophytes	3

Table 4: Analysis of variance based on Duncan test

Source of research	df	SS: Plants	SS: Plant diversity	SS: Biomass	SS: Cover percent	Average of square: Plants	Average of square: Plant diversity	Average of square: Biomass	Average of square: Cover percent	F: Plants	F: Plant diversity	F: Biomass	F: Cover percent
Treatment	4	906130.60	2268.9	4105685.8	23254.1	226532.6	567.20	1026421.4	5813.5	47.31*	42.08*	204.51*	381.96*
Error	20	95760.40	269.6	100377.9	304.4	4788.0	13.48	5018.8	15.2				
Total	24	1001891.04	2538.5	4206063.8	23558.5								

*: Significant at $p<0.01$, NS: Non Significant

Table 5: Variation of plants characteristic in different treatment by Duncan test

Treatment study	Plant density	Plant species No.	Shannon index: Diversity	Shannon index: Evenness	Cover (%)	Biomass production ($g\ m^{-2}$)
Grazed range	350^{c}	17.0^{b}	1.560	0.442	57^{c}	48^{b}
Wheat	187^{b}	4.0^{a}	0.145	0.061	86^{d}	280^{d}
Fallow	15^{a}	3.8^{a}	2.030	0.978	5^{a}	7^{a}
Annual medic	68^{ab}	3.7^{a}	0.298	0.152	28^{b}	45^{ab}
Exclosure	520^{b}	27.0^{c}	1.960	0.509	80^{d}	98^{c}

Within columns for each parameter and treatment, Means with the same superscript letter(s) are not significantly different at $p<0.01$

the plant diversity. With regard to Duncan test and the diversity index of Shannon's Diversity, the treatment of exclosure pasture was more diverse and equal than the rest of the treatments. Shannon's diversity index was used in treatment number 6 (the exclosure pasture having the maximum diversity) to determine the effect of plot positioning in sampling unit. The result also illustrated that the plot number 5 had the maximum diversity and equally constancy. So to speak, the measurement of bio-mass and the percentage of canopy cover of plant in these treatments revealed the fact that there was a significant difference among treatments. The treatments of wheat cultivation and the exclosure pasture had the maximum plant biomass (Table 5).

DISCUSSION

The rainfall of the region made the anticipation that the majority of plant species would be Therophytes and annuals regarding Rankayer's classification. This fact also reported by other researchers because the region under study had the driest days in a year (regarding Amberege's classification). In this climate plant species (their seeds) have to be buried into the ground in order to survive in harsh season conditions and then grow again in convenient temperature and rainfall. The dry climate and insufficiency of rainfall also caused the dominance of Poaceae family due to their resistance to dry climate. The diversity in annual medics and Trifoliate family in the region under study made Fabaceae family have the most diversity due to pass harsh dry season, burying their hard-cover seeds into the ground.

The Duncan test illustrated that there was the maximum number of plants and plant diversity in the treatment of exclusion pasture approved by Shannon's diversity index. The treatment of exclosure pasture had the maximum plant diversity, consistency and the number of plants which agree to Sprugel's (1991) study. This result differed slightly from Ghlichnia's (2006) because the comparison made by him was based upon the treatment of exclusion under balanced grazing.

It showed that the balanced grazing caused natural harvest which controlled the competition among plants. But both studies came to the same conclusion concerning the amount of bio-mass production. The studies done by Planning and Budgeting Organization (2005) and Sara and Cousins (2005) demonstrated that diversity could be observable in the lands where there were no human interferences and change in land use. Nowadays researchers and scientists regard pastures as a genetic bank rather than a source of cattle nourishment and so on. As the present study revealed, the exclosure of pasture is the best way to protect plant cover in order to preserve water, soil and plant diversity which keep safe genetic banks. It also moderated climate conditions and safeguarded medical herbs, wild life, an parks. The measurement of the plant bio-mass in wheat treatment was more than other treatments. But it does not mean that marginal lands were used in a correct way because the plant bio-mass will not be existed in all over the year consistently and each year the lands should be plowed to be cultivated. This will cause serious damages due to soil erosion, loss of water and decrease of plant diversity. In this treatment the percentage of plant cover was equal to the treatment of exclosure pasture. So it can be concluded that the increase in the percentage of plant cover means the enhancement of soil protection against water and wind erosion. It must keep in mind that the maximum percentage of cover in wheat treatment could not be observed in autumn when there was maximum rainfall. So to speak, it had no significant effect on protection of water and soil. There was a perfect protection of water and soil in the treatment of exclosure pasture due to satisfactory percentage of plant cover in all over the year.

The reason why the treatment of medic had more diversity than the wheat treatment and fallow would be explained in terms of the fact that this treatment was closer to the treatment of exclosure pasture. The measurement of diversity and consistency in the treatment of exclosure pasture demonstrated that the frame No. 5 was more diverse and constant than the rest of the frames. The reason was that this repetition located in the low part of the slope. This region had deeper soil so it bore more penetrating effect which provided better condition for the growth of plants. Regarding Table 1, it can be claimed that Shannon's diversity index is not suitable for measuring diversity and consistency in the regions where the number of plants is small and this small number exists in all of the frames.

Thus there were minimum plant diversity and minimum number of plant in the treatment No. 3 in comparison with the rest of treatments. But the suitable propagation of this small number of plant type and plant illustrated that this treatment had high diversity and consistency in comparison with the other treatments.

CONCLUSION

It can be concluded that the modern use of pastures as a genetic bank, protection of water and soil, wild life, medical herbs, parks, moderation of climate and other public benefits, except the supply of forage for cattle, support the idea that they should be used as exclosure pastures. This can be generally recommended for all pastures. The change of marginal lands into exclosure pastures will be of high importance here.

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