

Study of Grazing Intensity on Organic Matter and Soil Nitrogen Changes at Gardaneh Zانبوري Rangeland of Arsanjan, Iran

Zeinab Khademolhosseini

Instructor,

Department of Natural Resources and Environment,
Payame Noor University, Iran
Email: zbkhadem@pnu.ac.ir

Negar Yazdani Jahromi

Associate Professor,

Department of Natural Resources and Environment,
Payame Noor University, Iran
Email: negar.yazdani.j@gmail.com

Abstract – Presence of livestock as an integral component in rangeland ecosystems could be effective as different ways on grassland soil. Assessing the effects of grazing for finding of appropriation management policy and adopting of appropriate strategy is necessary for grazing in the rangelands of country. This is very important especially in arid and semiarid ranges. To investigate of grazing intensity effect on organic matter and soil nitrogen changes at 3 zones: The reference zone, Critical zone and key zone at Gardaneh Zانبوري rangeland of Arsanjan, soil sampling was carried out as systematic randomly and from two horizons from 0 to 15 cm and from 15 to 30 cm. At every horizon, 5 samples were sampling and organic carbon factors, organic matter percentage, the ratio of carbon to nitrogen and the total of nitrogen were measured. Data analysis was carried out by SPSS software and comparing of mean values for each factor and between areas with different grazing intensity was done by Tukey test. The results of two-way analysis and Tukey test showed that there is not any significant difference between critical and reference zones as studied factors. But, at key zone the values of organic carbon, organic matter and nitrogen percentage is lesser than critical and reference zones, while the value of C/N is greater than the other two zones.

Keywords – Arsanjan, Grazing Intensity, Organic Carbon, Organic Matter, Nitrogen, C/N.

I. INTRODUCTION

The range as a natural ecosystem is influenced by ecological relations. This means that the set of components and elements are in constant interaction with each other. Because of proper management on rangeland ecosystem requires a correct understanding of the relationships between ecosystem components, so, in order to preventing of unwanted and harmful changes and for thinking of necessary plans for protection, restoration, modification, development and fundamental operation of rangelands, it is necessary that a pasture manager sufficiently be aware of his management unit component (water, soil, plant, animal, ...) and how and quantity of their interaction.

Soil is one of the most important components in grassland ecosystems which consider as a resource and is the most important civilization foundation in each country. The factor which constantly threatens to the soil and water is erosion that acts for erasing of them (Refahi, 2000). There are many factors which cause to the soil erosion, one of these factors, is excessive number of livestock grazing which at different intensities it has different

effects on the range soil and plants. Many studies have been conducted about the grazing intensity effects on the soil physical and chemical properties, around the world and the different results have been reported. This may due to the different circumstances of the climate, soil, vegetation, pasture management and the kind of the utilize livestock. Johnston *et al.* (1971), by investigating of long term effects of livestock grazing on Alberta range soil, reported that moderate grazing caused to the further decomposition of plant residues and organic nitrogen mineralization but there is not any difference between two heavy grazing and not grazing zone. Singh *et al.* (1991), were reported in their research that increasing of livestock waste helps to the soil nitrogen recovering. Frank *et al.* (1995), were studied the long term effects of three treatments heavy grazing, moderate grazing, and enclosure on the grassland soil nitrogen and carbon, also, indicated that the total effect of enclosure is more than two other treatment and concluded that livestock grazing reduces the soil nitrogen. The amount of soil organic carbon in enclosure is more than moderate grazing but there has not observed any difference between enclosure zone and heavy grazing zone.

Potter *et al.* (2001), were concluded that the amount of the soil organic carbon and soil nitrogen is decreased by increasing of grazing intensity and the most values were measured at enclosure treatments. The results of Sanadgol (2002), showed a proportional increasing in grazing intensity, amount of organic matter and soil nitrogen is reduced in Absard Hamand station. Mohammadi & Raiisi Gahrooi (2003), in their investigation about long term effects enclosure on the spatial variability of soil chemical properties in enclosure and non- enclosure areas in Sabzkuh area of Chaharmahal and Bakhtiari, concluded that, the average amount of organic matter in both the enclosure and overgrazing is approximately equal but the amount of the total nitrogen in enclosure sites is more than overgrazing site.

Leibig *et al.* (2006), were examined the soil changes of one range at the north of American over a period of 70 years and at the three zones of moderate grazing at long term, heavy grazing and grassland with high fertility. The results showed that the amount of organic carbon of upper soil horizon in two areas of heavy grazing and fertile grassland is more than moderate grazing zone. Golluscio *et al.* (2009), were carried out a study in steppe rangelands of south American and reported that, the grazing caused to decreasing of organic carbon matter of soil as significantly

and proposed that the zone management should be able to combine the key species changes with life form, biogeochemical process and important role of the dead matter for protecting of nitrogen and carbon. Azarnivand et al. (2009), reported that livestock grazing can change the carbon and soil nitrogen storage but the amount of these changes will depend on the grazing intensity.

Heidarian Aghakhani et al. (2010), concluded that by increasing of grazing intensity the amount of soil carbon, nitrogen and organic matter will be reduced in Sysab Bojnurd pastures. It also, stated that the heavy grazing by negative changes in soil nutrient, threatens the range ecosystem sustainability. The results of Lie *et al.* (2011), in China showed that by grazing intensity increasing at heavy grazing zone, the amount of organic matter is increased as significantly and so, they stated that livestock grazing could have the potentially positive effect on the soil properties such as organic carbon. But they recommended the moderate grazing in order to constant exploitation and establish a balance between conservation of biodiversity, livestock productions and soil carbon and nitrogen management. Zarekia *et al.* (2012), reported that there is not any significant difference between zones in term of soil organic nitrogen and carbon at Saveh steppe grassland and also stated that the moderate grazing caused to the little changes on the soil physical and chemical properties in this zone. Arsanjan rangelands are located under the high stress of grazing in Fars province, because of placing on nomad's route and presence of rural livestock overcapacity in this area. Since the components of an ecosystem have the relationships and interactions with each other and given the vital role of soil in rangeland ecosystems, this study was done by aimed to determine the effects of different grazing intensities on soil properties, to determine the best livestock intensity at Gardaneh Zambouri rangeland of Arsanjan

MATERIALS AND METHODS

Description of the study area

Gardaneh Zambouri rangeland with an area of 2412 acres in Arsanjan city, is located at a distance of 17 km east of this city between east longitude from 53° 23' to 53° 26' and from 29° 51' to 29° 54' at North longitude. This is an area of mountains, hills and plains, the maximum

height is 2280 meters above sea surface and the minimum height is 1640 meters above sea surface. Steep slope is varies at different sections and its dominant slope is north-south. The average rainfall in the area, according to the weather station of Arsanjan is 443.5 mm, the mean temperature in the warmest month of year is 34 °c and the mean temperature in the coldest month of year is - 9.2° c (Khademolhosseini 2004; 2010).

Methodology

Because of the area was under three different management of enclosure, moderate grazing and heavy grazing so, after clarifying the scope of the field, soil sampling was performed.

These zones, were symbolic of grazing intensity and includes of reference zone without grazing, moderate grazing to heavy grazing was applied at key zone and the critical zone which was under heavy grazing and all characteristics such as topography, the soil type and rainfall were similar each other and they differed only at grazing intensity factor. Soil sampling was carried out as random - systematically from two horizons of 0 to 15 cm and 15 to 30 cm. At every horizon 5 samples were done and in total 30 sample of soil were transported to the laboratory. The samples were dried in air laboratory and after smashing they transmitted from 2 mm sieve. Carbon was measured at laboratory by Walkley and Black method (soil organic Co₂ in presence of potassium dichromate and concentrated acid and then titration with ammonium ferrous sulfate (Nelson & sommers, 1982). The percentage of soil organic matter was found by carbon multiplying percentage at 1.72 numbers. The total of soil nitrogen was measured by Kajeldal method (Brenner, 1960). Data analysis was done by SPSS software. After variance analysis and knowledge of averages meaningful, averages comparing was done by Tukey test. It is necessary to say that, in the absence of meaningful of F test; the comparing operation was not carried out.

III. RESULTS

Two- way analysis of variance for the factors is shown in table1. By studying of this table can be seen that there is significant difference between 2 sampling depths at 5% level in terms of carbon and organic matter percentage carbon to nitrogen. While there is not any

Table 1: Two-way analysis of variance for investigated factors

Factor	Changing source	Depth	Grazing intensity	Depth * Grazing intensity
%OC	F value	77.067	15.267	38.867
	Significant	0.000	0.000	0.000
%OM	F value	85.422	14.467	40.156
	Significant	0.000	0.000	0.000
N	F value	4.064	40.070	32.568
	Significant	0.055	0.000	0.000
C/N	F value	0.054	13.153	1.594
	Significant	0.818	0.000	0.164

Significant difference for soil total nitrogen and the ratio of carbon to nitrogen. The different levels of grazing intensity also show significantly different at 5% level in all examined parameters. On the other side there is significant difference between depth and grazing intensity levels at 5% level about carbon, organic matter and the total of nitrogen. This means that there is interaction between depth and intensity. This option is not significant only for the ratio of carbon to nitrogen.

After ensuring of different meaningful for comparing of the averages which related to the different levels of grazing, the Tukey test was used. The results of Tukey method for average grouping are given in table 2. As observed in table, there is not any significant difference between enclosure zone and heavy grazing intensity zone, while there is significant difference between the enclosure zone and moderate grazing zone in 5% level as statistical

analysis. Also, there is significant difference between the area under the heavy grazing and the area under the moderate grazing treatment at 95% certainty for soil organic carbon. According to this table, there are two distinct groups. The first group includes of moderate grazing, while the second group was encompassed the enclosure and heavy grazing simultaneously which indicate that these two regions do not differ in terms of studied factors. The point of this table is that the values of the first three factors at moderate grazing zone is lesser than two other zones. While the factor of carbon to nitrogen ratio it has reverse process. For the depth of sampling due to there is not more than two depths whereas the average comparison has not done less than three characters, so, the comparison of averages were carried out only for grazing different levels.

Table 2: The results of Tukey methods for homogeneous averages grouping

Factor	Grazing intensity	Subgroups at 5% level	
		1	2
%OC	Moderate	0.8870	
	Heavy		0.8990
	Enclosure		0.9040
	Significant	1.000	0.273
%OM	Moderate	1.5240	
	Heavy		1.5430
	Enclosure		1.5530
	Significant	1.000	0.183
N	Moderate	0.031250	
	Heavy		0.065350
	Enclosure		0.068250
	Significant	1.000	0.805
C/N	Enclosure	13.9270	
	Heavy	15.9180	
	Moderate		34.3280
	Significant	0.893	1.000

IV. DISCUSSION AND CONCLUSION

By investigating of the results, it has been observed that the amount of the organic matter and soil organic matter in first horizon (0-15cm) is lesser than second horizon (15-30cm).

There is not any significant difference between two investigated depths for total percentage of nitrogen but the amount of that in enclosure zone and the first depth is greater than second depth. While at heavy and moderate grazing, the amount of this factor at second depth is greater than first depth. Also, there is not any significant difference for C/N ratio at the first and second depth. But its amount at the heavy grazing zone at the first depth is greater than the second depth. While at enclosure zones and moderate grazing zones this ratio at second depth is greater than the first depth. Zhong *et al.* (2005), in a study of rangelands of Northern China found that two reasons of

organic Carbon reduction at surface as compare to the subsurface zone of soil is overgrazing and light texture which caused to leaching of organic matter from the surface to the underlying horizons.

On the other hand, the process of organic carbon changes, organic matter, the ratio of C/N and the percentage of total nitrogen are similar in this research. By attention at results could be seen that there is not any significant difference between enclosure zone and heavy grazaing zone in terms of organic carbon amount, organic matter, C/N ratio and total nitrogen percentage. Researchers like Frank *et al.* (1995), Menzes *et al.* (2001) and Mohammadi & Reisis Gahrooii (2003), also in their studies found that there is not any significant differences between soil carbon and organic matter between enclosure and under grazing zone and they attributed its reason to heavy grazing species composition changes.

Also, there is significant difference between moderate grazing zone and enclosure and heavy grazing zone so, the amount of organic Carbon, organic matter and the total of nitrogen percentage at moderate grazing is lesser than two other zones. While the ratio of C/N in this area is greater than the other two districts. Leibig *et al.* (2006), also reached to the similar results. Here we are faced to two problems. First, the amount of organic Carbon, organic matter and total nitrogen percentage at moderate grazing is lesser than enclosure zone. By increasing of grazing intensity the amount of soil organic Carbon is reduced. This is due to overexploitation of surface vegetation in higher intensity grazing which caused to decreasing of plants residues arrival and as result caused to decreasing of organic matter arrival to soil which this impairs the activity of degrading microorganisms and reducing of organic matter decomposition and reducing of soil fertility of soil. Also, the intensive grazing affects on soil nutrient amount by changing the plants life form and stepping acts. With reduction of litter biomass because of leaf and grain grazing and shrinking residues because of animal transportation, soil temperature is increased and the rate of decomposition at intensive grazing is increased. This result is agreement with the results of some researchers like Liu *et al.* (2012), Glousio *et al.* (2009), Vermire *et al.* (2005), Schuman *et al.* (1999), Azarnivand *et al.* (2008) and Javadi *et al.* (2004). The second problem is that the amount of organic matter, organic carbon and total nitrogen percentage in moderate grazing zone is lesser than the area under the heavy grazing. The surveys conducted by Johnston *et al.* (1971), Dormaar *et al.* (1994) and Sharif *et al.* (1994), showed that the moderate grazing caused to further decomposition of plant residues and being mineralization of organic nitrogen but there is not any difference between heavy grazing and not grazing zone. The amount of soil organic carbon in heavy grazing intensity increases since several mechanisms. First, with soil compacting and increasing of bulk density, soil oxygen supply is reduced and the rate of degradation is decreased (Li *et al.*, 2001). The second mechanism is that intensive grazing by changing the composition of plant and root ratio to stalk, can affect the root biomass share in the pool of soil organic matter (Reeder *et al.*, 2004). In fact, the livestock grazing increases the ground biomass share (Hui & Jackson, 2005). Root share increasing, causes to carbon arrival to the soil, increases nitrogen stored in soil and leading to high accumulation of organic carbon in soil. Nitrogen deposition in tissues of root and closed rotate in root is announce as nitrogen reserves mechanisms (Stewart & Frank, 2008). Carbon and nitrogen increasing could leads to grazing effect increasing in root biomass and plant residues because the roots and plant residues are important sources of carbon and nitrogen in grasslands (Gao *et al.*, 2009). Thirdly, animal faces and urine can speed the nitrogen cycle in grasslands ecosystems (McNaughton, 1997). The results of some researchers studies like Lie *et al.* (2008), Aghamohseni Fashami *et al.* (2007) and Mohammadi *et al.* (2000), supporting this idea.

It looks that simultaneous effect of aforementioned factors in studied rangeland, caused to have not observed any significant difference between enclosure areas and under heavy grazing of organic carbon, total nitrogen and organic matter percentage. Thus, in one hand because of the desirable vegetation and lack of exploitation at enclosure area and the other hand as effect of severe grazing and effects of above mechanisms in heavy grazing zone the balance is created which caused to increasing of carbon arrival to soil at both locations and therefore can not see any difference between these two regions. Meanwhile, despite of the vegetation and rangeland forage usage in moderate grazing zone we observed the organic carbon entering to the soil as much lower. It seems that by applying the light grazing to moderate grazing in the area in addition to exploitation of rangeland productive forage to achieve the goal of carbon maintain and organic matter of soil.

ACKNOWLEDGMENT

This paper was extracted from Payame Noor University research project of Iran. We express our gratitude for cooperation of this university.

REFERENCES

- [1] Aghamohseni Fashami, M., Zahedi Amiri, G., Farahpour, M. and Khorasani, N., 2007. Influence of enclosure and grazing on the soil organic carbon and soil bulk density, case study: in the central Alborze south slopes range lands. *Iranian Journal of Agriculture Knowledge*, 5(4), 375- 381.
- [2] Azarnivand, H., Joneidi Jafari, H., Zare Chahooki, M.A., Jafari and M., Nikoo, S., 2008. Investigating of livestock grazing effect on Carbon sedimentation and Nitrogen storage in ranches with *Artemisia sieberi* in Semnan province. *Ranch Journal*. 3(4), 590- 609.
- [3] Brenner, J.M., 1960. "Determination of Nitrogen in Soil by kjeldahl Method. *The Journal of Agricultural Science*, 55 (1), 11- 33.
- [4] Dormaar, J. F., Williams, W. and Adoms, W., 1994. Effect of Grazing and Abandoned Cultivation on a *Stipa-Bouteloua* Community. *Journal of Range Management*, 10 (47), 129- 135.
- [5] Frank, A.B., Tanaka, D. L., Hofmann, L., and Follet, R.F., 1995. Soil Carbon and Nitrogen of Northern Great Plains Grasslands as Influenced by Long- term Grazing. *Journal of Range Management*, 48, 470- 474.
- [6] Gao, Y. H., Schuman, M., Chen, H., Wuand, N. and Luo, P., 2009. Impacts of Grazing Intensity on Soil Carbon and Nitrogen in an Alpine Meadow on the Eastern Tibetan Plateau. *Journal of Food Agriculture Environment*, 7, 749- 754.
- [7] Golluscio, R.A., Austin, A.T., Garsia, G.C., Martinez, M. Gonzalez-polo, O. E. Jackson, R.B., 2009. Sheep Grazing Decreases Organic Carbon and Nitrogen Pools in the Patagonian Steppe: Combination of Direct and Indirect Effects. *Ecosystems*, 12, 686- 697.
- [8] Heidarian aghakhani, M., Naghipour Borj, A. and Tavakoli, H., 2009. Survey of grazing intensity effect on vegetation and soil at Sysab Ranches of Bojnourd. *Journal of Iran Ranch and dessert Researches*. 17(2), 243- 255, Tehran.
- [9] Hui, D. and Jackson, R. B., 2005. Geographic and Interannual Variability in Biomass Partitioning in Grassland Ecosystems: A Synthesis of Field data. *New Phytologist*, 169, 85- 93.
- [10] Javadi, S.A., Jafari, M., Azarnivand, H. and Alavi, S.J., 2004. The effect of grazing intensity on the soil organic matter and soil nitrogen at Lar grassland", *Journal of Natural resources*, 58(3), 711- 718.

- [11] Johnston, A., J., Dormaar, J.F. and Smoliak, S., 1971. Long – term Grazing Effects on Fescue Grassland Soils. *Journal of Range Management*, 24, 185- 188.
- [12] Khademolhosseini, Z., 2004. study of the relationship between plant communities with environmental factors in the area of Fars Province Bonab (Arsanjan), MA thesis, Mazandaran universities. P. 75.
- [13] Khademolhosseini, Z., 2010. Comparing of biodiversity numerical indicators at three sites with different grazing intensities (Case study: Gardaneh Zanbouri rangeland of Arsanjan). *Ranch journal*, 4(1), 104- 111.
- [14] Leibig, M. A., Gross, J. R., Kronberg, S.L., Handson, J. B., Frank, A. B., and Philips, R. L., 2006. Soil Response to Long – term Grazing in Northern Great Plains of North America. *Agriculture, Ecosystems and Environment*, 112, 270- 276.
- [15] Li, W., Huang, H.Z., Zhang, Z. N and Wu, G.L., 2001. Effects of Grazing on the Soil Properties and C and N Storage in Relation to Allocation in an Alpine Meadow. *Journal of Soil Science and Plant Nutrition*, 11 (4), 27- 39.
- [16] Li, C., Hao, X., Zhao, M., Han, G., and Willms, W.D., 2008. Influence of Historic Sheep Grazing on Vegetation and Soil Properties of Desert Steppe in Inner Mongolia. *Agriculture, Ecosystems and Environment*, 115, 270- 276.
- [17] Liu, N., Zhang, Y., Chang, SH., Kan, H. and Lin, L., 2012. Impact of Grazing on Soil Carbon and Microbial Biomass in Typical Steppe and Desert Steppe of Inner Mongolia. *Plos One*, 7 (6), 1- 9.
- [18] Menezes, R., Elliot, E. T., Valentine and, D. W. and Williams, S. A., (2001). Carbon and Nitrogen Dynamics in Elk Winter Ranges. *Journal of Range Management*, 54, 400- 408.
- [19] McNaughton, S. J., Banyikwa, F. F. and McNaughton, M.M., 1997. Promotion of the Cycling of Diet Enhancing Nutrients by African Grazers, *Science*, 278, 1798- 1800.
- [20] Mohammadi, J., Reisi, F. and Asadi Brojeni, E., 2000. Geostatistical analysis of long term enclosure and overgrazing on spatial structure of some of the soil properties. *Proceedings of Second National Conference of Pasture and Pasture Management of IRAN*.
- [21] Mohammadi, J., Reisi Gahrooi, F., 2003. Fractal characterization of long-term enclosure and overgrazing on pattern of spatial variability of soil chemical properties. *Science and Technology of Agriculture and Natural Resources, Isfahan Technology University*. 7(4), 25- 36.
- [22] Nelson, D. W. and Sommers, L. E., 1982. Total Carbon, Organic Matter. In: A. L. page. (Eds.), *Methods of Soil Analysis, Part II*. 2nd ed., Agron. Monog. ASA and SSSA. Madison, WI. 9, P. 539-577.
- [23] Potter, K. N., Daniel, J.A., Attom, W., and H. A. Torbert, H. A., 1995. Stocking Rate Effect on Soil Carbon and Nitrogen in Degraded Soil. *Soil and Water Conservation*, 56 (3), 233- 236.
- [24] Reeder, J. D., Schuman, G. E., Morgan, J. A., and Lecain, D. R., 2004. Response of Organic and Inorganic Carbon and Nitrogen to Long-term Grazing of the Short grass Steppe. *Environmental Management*, 33, 458- 495.
- [25] Refahi, H., 2000. Water erosion and its control, Tehran university publication. 551.
- [26] Sanadgol, A., Moghaddam, M. and Jafari, M., 2002, the effect of short term grazing on some of the soil chemical and physical properties in *Bromus tomentellus* pasture. *Iranian Journal of Natural resources*. 55 (4), 581- 596.
- [27] Schuman, G. E., Reeder, J.D., Manley, J.T., Hart, R. H., and Manley, W.A., 1999. Impact of Grazing Management on the Carbon and Nitrogen Balance of a Mixed Grass Rangeland. *Ecological Applications*, 19, 65- 71.
- [28] Sharif, A. R., Biondini, M.E., and Grygiel, C. E., 1994. Effect of Grazing Intensity Effects on Litter Decomposition and Soil Nitrogen Mineralization. *Journal of Range Management*, 17(6), 444- 449.
- [29] Singh, R., Raghubanshi, A. S., and Singh, J.S. 1991. Nitrogen Mineralization in Dry Tropical Savanna, Effects of Burning and Grazing. *Soil Biol. Biochemistry*, 23, 269- 273.
- [30] Stewart, A., and Frank, D., 2008. Short Sampling Intervals Reveal very Rapid Root Turnover in Temperate Grassland. *Oecologia*, 157, 453- 458.
- [31] Vermeire, L.T., Wester, D. B., Mitchell, R.B. and Fuhlen-dorf, S.D., 2005. Fire and Grazing Effects on Wind Erosion, Soil Water Content and Soil Temperature. *Journal of Environment Quality*, 34, 1559- 1556.
- [32] Zarekia, S., Jafari, M., Arzani, H., Javadi, S.A. and Jafari, A.A., 2012. Grazing Effects on some of the Physical and Chemical Properties of Soil. *World Applied Sciences Journal*, 20 (2), 205- 212.
- [33] Zhong, Y., Lin, L. Y., Jianand, C. and Wen, Z., 2005. Influences of Continuous Grazing and Livestock Exclusion on Soil Properties in a Degraded Sandy Grassland, Inner Mongolia, Northern China. *Catena*, 59 (3), 267- 278.