Advances in Bioresearch
Adv. Biores. 8 [Spl issue 1] 2016: 01-07

Print ISSN 0976-4585; Online ISSN 2277-1573
Journal's URL:http://www.soeagra.com/abr.html
CODEN: ABRDC3
ICV 86.92

Advances in Bioresearch

Full Length Article

Determining Effects and Potential of Biological Operations of Watershed Management in Carbon Sequestration to Modify Climatic Changes (Lorestan)

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ABSTRACT
Nowadays, earth's warming and climate change caused by intensive greenhouse effect resulting from carbon gas emissions to the atmosphere is regarded as one of the most important threats to the sustainable development and food security especially in arid and semi- arid regions of world such as Iran. Expansion of use of fossil energy resources for industrial activities, destruction of forests and ranges (grasslands) and also land and soil degradation has been cited as the main reason of this issue. Carbon sequestration by ecosystems of plants with the efficient management tools such as efficient biological operations is the only known non- technological solution. Two areas were selected as site of treatment in order to estimate the amount of carbon sequestration; so that each of the two areas was sampled according to random – systematic method using transects and plots. Then, samples were weighed and their weighs were identified according to plot in each area and hectare. After that, 10 grams of each sample was transferred to the laboratory and the amount of sequestration was determined per unit area. The results show that sample treated basin of Rimeleh with 2025 kg per ha land area enjoyed the maximum carbon sequestration amount while control sample basin aquifer with 122 kg has the minimum carbon sequestration amount per ha land area. From biological operations point of view, seeding project with wheat in Rimeleh basic with 1064.56 kg per ha land area enjoyed the best performance in terms of carbon sequestration. Also, results of statistical analysis in software environment of "Minitab" and "SPSS" indicate significant differences (in five percent level) in terms of carbon sequestration in treatment and control sites.
Key words: Watershed Management, Carbon Sequestration, Climate Changes, Biological Operations

Received 20/07/2016 Accepted 20/11/2016

How to cite this article:
Mehran Lashanizand and Reza Siahmansour, Determining Effects and Potential of Biological Operations of Watershed Management in Carbon Sequestration to Modify Climatic Changes (Lorestan), Adv. Biores., Vol 8 [Spl issue 1] 2016:01-07. DOI: 10.15515/abr.0976-4585.SI0107

INTRODUCTION

Nowadays, earth's warming and climate change caused by intensive greenhouse effect resulting from carbon gas emissions to the atmosphere is regarded as one of the most important threats to the sustainable development and food security especially in arid and semi- arid regions of world such as Iran. Expansion of use of fossil energy resources for industrial activities, destruction of forests and ranges (grasslands) and also land and soil degradation has been cited as the main reason of this issue.

The stakes and risks of this phenomenon are very comprehensive and vast. Among these risks, it should be referred to the degradation of land areas, reduction of production stability and quality of biomass resources, air pollution, water and soil and environmental problems, increase of flood events and extinction of several species of flora and fauna (plant and animal species). Human activities influence on the climate and in its turn, climate affects agriculture, human and animal food resources. In a forum held in Copenhagen in Dec. 2009, it was warned that with climate change and global warming, the Earth will face with water scarcity (30- 40 percent) by 2020 [3].

It should be noted that methods and methodology of assessing and evaluating the location of concept of carbon sequestration, *depending on the purpose of the study, the profile of the area under study and the* *theoretical effects of physical and management factors affecting sequestration and finally level of access to data*, is different. For this important issue, tools such as data mining methods, modeling and dynamic and static situation of carbon sequestration and destruction of carbon, systems of artificial intelligence, multivariate analysis statistical methods and also workplaces and geomatics and geo- statistics analysis is used. *Povirk et al* [16] showed that approx. 80 percent of root biomass and soil carbon sequestration capacity of soil is focused at the depth of soil 30 to 40 cm. The effect of climatic factors especially temperature on carbon sequestration was studied by [4, 1].

These research studies showed that temperature decreases carbon sequestration through increased organic matter decomposition. They raised that steppe and semi- steppe regions and generally arid and semi- arid regions are the best target places in the world for sequestration process. Results of study conducted by Lal [7] showed that conversion of forest and range ecosystems to agricultural ecosystems caused a loss of about 30 to 50 tons of carbon per hectare land area during the year. In a research conducted in China, Lal [8] concluded that management methods make the amount of organic carbon lost returns. Merino *et al* [15] in a study examined and evaluated the effects of soil management and change of land use in carbon sequestration and flow of greenhouse gases at three land uses of 1- adjacent to forest, 2- rangeland, and 3- agricultural land using descriptive – regression statistical methods and also comparison of means.

Woomer et al. (2004) studied the amount of carbon sequestration in plant and soil in various treatments of grass, shrubbery and forest and showed that 60 percent of sequestrated organic carbon is stored at a depth of 20- cm of soil. It should be noted that forest and rangeland areas are almost equivalent in world in terms of potential of sequestration. In general, carbon sequestration has been stable at the rangelands that have been put under cultivation or the influx of woody plants. Liu et al [12] and Liao [11] showed that biomass carbon can be increased through the cultivation of fast growing tree species compatible with a dilapidated range. Although this operation caused reduction of soil carbon in the short term, it caused promotion of carbon sequestration in this area in the long term. Fang et al [3] studied the amount of biomass production and saving carbon in poplar plantation in China. They showed that afforestation is the most important factor affecting sequestration of cultivation work. Results of various studies show that under the controlled management systems on the range, total carbon sequestration is increased significantly in biomass, litter and soil as compared with the uncontrolled or improper management system [2]. It should be noted that the effect of management factors and reduction of carbon sequestration per unit of time depends on the growth characteristics of plant species, management method (how to manage), reducing operations, and physical and biological conditions of soil and previous storage of carbon in soil[12].

Law et al [10] determined the distribution of soil organic carbon in a large oil palm with three common management models to help determine normal cringing. Sampling was systematic and proper variogram model of exponential and/or spherical type was diagnosed. The results showed that the effect of management type is very important in creation of spatial structure of soil organic carbon and consequently, routing carbon sequestration in soil. Henry et al [5] stated that trunk of trees account for maximum aerial Bole Mass related to a tree, which is considered as “Bole Mass”.

Regarding the study of distribution amount of carbon sequestration of plant Bole Mass in various physiographical units, Marshall et al [14] acknowledged that along all factors, physical factors of slope and elevation from sea level include about 63.7% of changes of amount of aerial sequestration.

MATERIALS AND METHODS

In this study, two areas were selected in different parts with vegetation and different watershed management operation as follows:

1- Rimeleh area located at 30 km north of Khorramabad city on a land area as large as 8,000 square meters. From geological point of view, this area has Gurpi formation comprising light green marl and calcareous sandstone layer which is between the relatively deep incorporates with moderate to high erosion. In this site, soils have evolved and enjoy thermal regime of mesic and xeric moisture regime. The herbal vegetation of area is mostly observed with various species of : (*Quercus persica*) (*Daphne mucronata*. (*Pyrus glabra*) ‹(*Ficus carica*) (*Crataegus monogyna*. ( )*Amygdalus scoparia*) (*Amygdalus lycioides*) ‹(*Pistacia mutica*) (*Salix sp.*) (*Acer sp.*) ‹*Verbascum thapsu.* Lashni Zand et al (2013)

The understory herbaceous species include as follows: Aegilops ovata ‹ Bromus tectorum‹ Bromus madritensis‹ Boissiera squarrosa Medicago SPP ‹ Trigonella‹Onobrychis SPP, Papaver‹ Vicieae‹Bromus tomentellus ‹ Festuca ovina‹Agropyron trichophorum , Stipa SP.‹ Agropyron tauri , Poa bulbosum ‹ Onobrychis cornolata, Euphorbia, Aegilops cylindrica ‹ Gundelia tournefortii, Digitaria SPP.

2- Kouhdasht Aquifer Basin is located in Davoud Rashid Region, 8 km north of Kouhdasht, about 90 kilometers west of provincial center of Lorestan, Khorramabad. This basis has been constructed with the aim of injecting and guiding seasonal runoff and planting different plant species. The amount of rainfall (precipitation) in this basin is 420 mm. This area is covered from coarse sediments in Quaternary Geology and is located at the core of an eroded anticline. This basin has shallow soil and enjoys thermal regime of thermic and xeric moisture regime.

The herbal vegetation of basic is composed of five types as follows:

Astragalus - Euphorbia
Agilops – Medicago spp
Astragalus - Annual grasses -
Gundelia - Annual grasses -Annual forbs
Amygdalus - Astragalus

The following plant species can be observed in this basic sporadically: Quercus Persica, Crataegus monogyna, Amygdalus scoparia, Amygdalus lycioides (Lashni Zand et al. 2013)

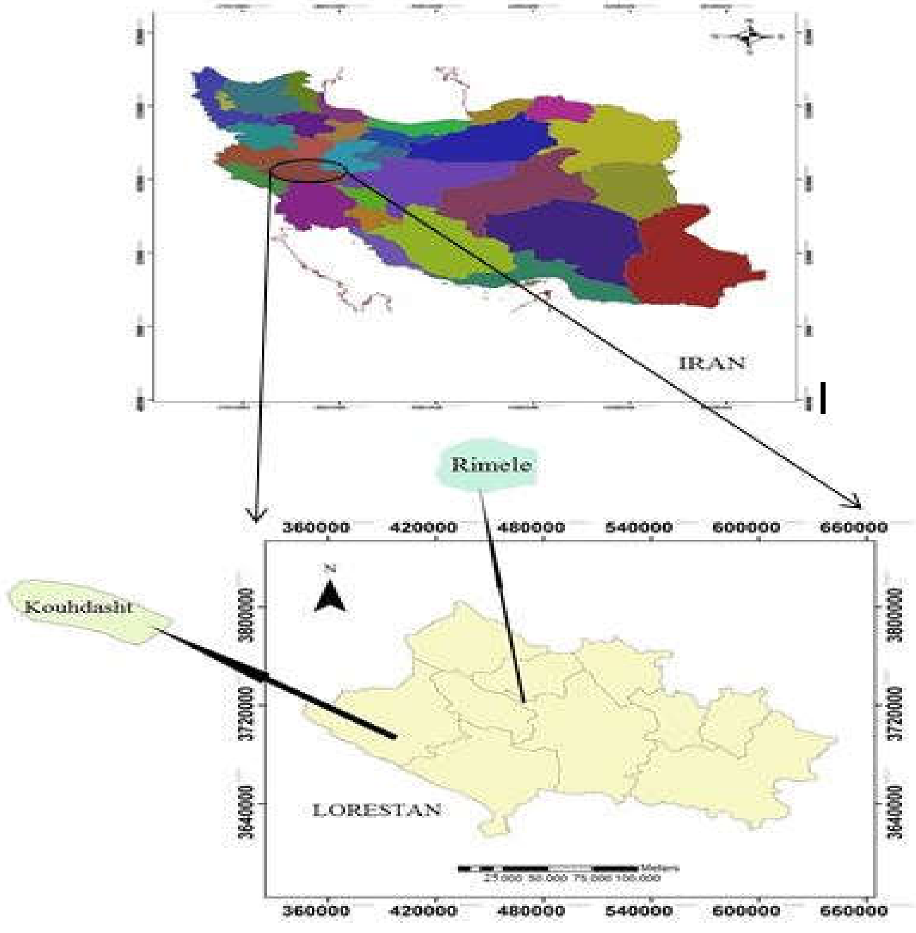

Fig. 1: Situation of Basins under Study

In this study, available reports and maps have been used. Then, required data and statistics from watershed rehabilitation activities were collected in the areas. Both treatment and control sites were mapped by doing field inspections. Since the characteristics of land types, type of formations, vegetation type, and slope of land areas, rock outcrops, and watershed management operations carried out on the treatment and control sites are in an acceptable range, therefore, sampling method was selected randomly. It should be noted that sampling is applied in direct basis using transects and plots, so that a number of six 50- m transects were selected and one plot was studied on it randomly at the distance of each 10 meters. In other words, a number of 30 plots were studied in both treatment and control separately. In general, 60 plots were studied in each site and totally, 120 plots constituted subject of study in two plots. In these plots, statistics were taken separately according to the aerial organ, root and amount of litter, so that amount of biomass can be computable. In this situation, data were analyzed.

After drying completely, the samples were placed in an oven at 70 ° C for a period of 24 hours, depending on the type of species, rate of moisture and/or type of organ and then, they dried up. [18].
Then, a number of 15 10-gr samples composed of root, 15 10- gr samples composed of aerial organ and also 15 10-gr samples composed of litter of treatment area were transferred to the laboratory. In addition, the same amount of control area, as mentioned above, was transferred to the laboratory in order to measure the amount of carbon. To determine the amount of organic matter, species of plant is used through combustion method. Plant species were placed in the oven at 60 °C for eight hours or 40 °C for 15 hours minimum in order to be dried. Then, samples were milled and crushed. At the next stage, two 10-gr samples were weighed and were put at the furnace for 24 hours at 450 °C. Then, samples were cooled in desiccator and placed in the oven for a period of one hour again for more assurance and after that, they were weighed. The weight obtained in the treatment of ash. In this method, the amount of reduced weight of matter remained at the furnace is equivalent to the organic matter which a plant owns. In order to determine the weight of organic matter of the plant, the following equation (1) is used.
Equation 1:
Om= w1 – w2
Wherein:
OM represents the weight of organic matter of plant according to gr
W1 represents the primary weight according to gr
W2 represents the secondary weight according to gr
Studies show that 54 percent of organic matter is equal to the carbon exists at plant. (Ritson & Sochaki, 2003)
Therefore, percentage of carbon available at plant is calculated according to the following equation (2):
Equation 2:
OC= 54% OM
Wherein:
OC represents the amount of carbon available at plant (percent)
OM represents the amount of organic matter in plant (percent)

RESULTS
In order to determine the success amount of treatments in the amount of carbon sequestration, each of target parameters was compared with their corresponding amounts in the control. It should be noted that determination of the amount of carbon sequestration has been conducted with the analysis of data in the fields that selection of basin and biological operation has been turned "successful".
In the same direction, the amount of organic matter, the amount of carbon sequestration, percentage of organic matter as well as percentage of organic carbon of the samples received from the treatment and control part were collected and developed in "Excel" and "MiniTab" software packages.
It should be noted that data were compared with each other using paired-T test. The results of organic matter and percentage of organic carbon at two basins were compared with each other using statistical analysis method, the results of which are as follows:

Comparing Means of Two Independent Samples
To compare the independent samples, paired T-test is used, the results of which have been shown in Table (1) and (2).

Table 1: Test for storing carbon in independent samples of control and treatment root for aquifer basin in Kouhdasht and Rimeleh

Variable	N	Mean	St DeviTion	SE Mean	DF	T-value	P-value
Kouhdasht Aquifer treatment	12	50.57	1.63	0.147	13	3.03	0.005
Kouhdasht Control aquifer	3	46.76	4.85	2.8			
Reymaleh Aquifer treatmen	8	51.08	1.66	0.589	14	2.51	0.013
Reymaleh control aquifer	8	50.81	1.76	0.622			

The amount of degree of freedom for the root samples of aquifer basin and Rimeleh stands at 13 and 14 respectively and p- value statistics in 5% level is smaller than α . Accordingly, this hypothesis is rejected.

In other words, carbon storage mean in aquifer treatment and Rimeleh with control have significant difference.

Table 2: Carbon Storage Test of Independent Samples of Control and Treatment Aerial Organs for Aquifer Basins of Kouhdasht and Rimeleh

Parameter	N	Mean	St Deviation	SE Mean	DF	T-value	P-value
Kouhdasht Aquifer treatment	32	49.77	2.03	0.36			
Kouhdasht aquifer Control	7	45.65	2.09	0.79	28	4.75	**0.001**
Reymaleh Aquifer treatment	10	51.61	1.48	0.52	16	-2.48	**0.025**
Reymaleh aquifer control	8	53.39	1.56	0.79			

The amount of degree of freedom stands at 28 and 16 for samples of aerial organs of aquifer and Rimeleh basin respectively. Accordingly, statistics p- value in 5% level is smaller than α. Therefore, this hypothesis is rejected. In other words, the carbon storage mean in aquifer and Rimeleh treatment basins have significant difference with the control basin.

Table 3: Estimating Carbon Storage Amount in Treatment and Control Basins

No	Site	Sample Type	Sample weight (kg/ha)	Carbon storage (kg/ha)
1	Reymaleh Aquifer treatment	Browse/ Canopy	3083	1604
2	Reymaleh Aquifer treatment	Root	1332	694
3	Reymaleh aquifer control	Browse/ Canopy	400	205
4	Reymaleh aquifer control	Root	134	66
5	Kouhdasht Aquifer treatment	Browse/ Canopy	400	205
6	Kouhdasht Aquifer treatment	Root	1211	608
7	Kouhdasht aquifer Control	Browse/ Canopy	363	122
8	Kouhdasht aquifer Control	Root	104	47

Comparing between control and treatment basins is shown in Table 3, indicating that treatment basins enjoy high potential in storing carbon.

With due observance to this important effect, carbon sequestration includes as follows: differences of storing carbon in biological operations of treatment regions from storing carbon in control regions in soil, biomass, litter and total parts. According to the results of this research, mechanical and structural operations of watershed management in carbon sequestration were calculated in the two basins (treatment and control) in order to correct climatic changes. The results obtained have been presented in Table (4) .

Table 4 : Estimation of total amount of carbon sequestration in the studied areas (kg per hectare)

NO	Site	Sample Type	Carbon sequestration (kg/ha)
1	Reymaleh	Browse/ Canopy	1398
2	Reymaleh	Root	627
3	Reymaleh	Biomass	2025
4	Reymaleh	Soil	19990
5	Reymaleh	Total	22015
6	Kouhdasht	Browse/ Canopy	137
7	Kouhdasht	Root	561
8	Kouhdasht	Biomass	698
9	Kouhdasht	Soil	30010
10	Kouhdasht	Total	30708

As it is observed in Table 3, from among biological samples, aerial organ (shoot) has had the maximum carbon sequestration in Rimeleh area. But due to the operation carried out, the amount of carbon sequestration of soil has been by far more than total carbon sequestration of biomass, especially in aquifer operations which has been estimated more than 30,000 kg.

A number of six biological projects were studied and compared within the two areas in order to determine ranking of various biological operations of wastewater management in terms of their role in carbon sequestration. The results are shown in Table 5.

Table 5 : Comparison of carbon sequestration in various biological operations (kg)

NO	Site	Biological treatment project	O.C (%)	O.M (%)	Sample weight (kg/ha)	Carbon storage (kg/ha)	Carbon sequestration (kg/ha)	Rank
1	Reymaleh	Seeding with legume plants	51.6	88.1	1164	600.6	463.18	3
2	Reymaleh	seeding wheat	52.36	90.1	2718.5	1423.4	1064.56	1
3	Reymaleh	Ridges seeding (Grasses & legume plants)	53.4	92.4	2146.4	1146.2	1010.26	2
4	Kouhdasht	Pasture planting (legume plants) & grazing management	49.33	88	654.4	322.82	222.65	4
5	Kouhdasht	Pasture planting (Grasses plants) & grazing management	50	85.7	350.8	175.4	74.81	6
6	Kouhdasht	Pasture planting (Other plants) & grazing management	50.1	88.7	584.5	292.8	192.78	5

As it is observed in table 5, the amount of storing carbon sequestration indicates significant differences due to the type of biological operations and sampled obtained in this regard.
In order to determine ranking of various biological operations of watershed management in terms of their roles in carbon sequestration, a number of six biological projects within the two area were studied and compared with the control samples of each area, the results of which are shown in Table 5.
A glance at Table 5, it can be concluded that biological operations of seeding with wheat in Rimeleh basin has had the best performance in terms of carbon sequestration with producing 1064.56 kg per hectare. However, biological operation of seeding with wheat stood at the first rank.
With comparing biological operation made in two basins, it is specified that biological projects conducted in Rimeleh basin has turned "successfully" in terms of carbon sequestration.

DISCUSSION AND CONCLUSION

Considering the results of tests and analysis of the information obtained in the studied basins, it is specified that potential of carbon sequestration is very high at the areas with watershed biological operations.
Su- Young [19], hill et al [2] and Derner et al [2] stated that most management factors are very important in carbon sequestration. Results of various studies show that carbon sequestration in biomass, litter and soil under the management systems controlled in forest and range increase significantly than the uncontrolled and/or inaccurate management systems. The results obtained from this study show that studied sites with watershed management biological operations enjoy accurate and controlled management system and have favorable carbon sequestration conditions than the areas that lack any type of management. For example, potential of studied samples in Rimeleh treatment area project is eight times more than control area sample in terms of amount of carbons sequestration.
Plan, Budget and Statistics Deputy Office of Iranian Watershed Management, Forest and Range Organization (2009) in a report presented an estimation of high capacity of natural areas of the country in carbon sequestration equal to 180 million tons of carbon/year.
Another study showed that Romeshgan flood distribution area with carbon sequestration as weigh as 78.4 tons per ha is a successful project in terms of carbon sequestration with the efficient management as well as biological and mechanical watershed operation, the result of which is consistent with the study conducted by Lashni Zand *et al* [9].
It should be noted that watershed management biological activities provide terms and conditions for increasing carbon sequestration. Considering the comparison between control areas with the sampling

location in treatment areas, which have gone under biological watershed operations, it was specified that terms and conditions of carbon sequestration were provided better at location which were put under biological operations in a way that amount of carbon sequestration in aquifer stood at 698 kg/ha on average while this amount stood at about 2,025 kg/ha for Rimeleh area.

With the studies conducted, it was specified that the amount of storing carbon indicate significant difference due to the type of biological operations and samples obtained in this regard.

For this purpose, ranking different biological watershed management operation was conducted in terms of their roles in carbon sequestration within the framework of six biological operation projects at the studied area and in comparisons with the control samples in each area.

The results show that biological seeding operations with wheat in Rimeleh Area had the best performance with 1064.56 kg/ha in terms of carbon sequestration and stood at the first rank.

With comparing biological operations in these two areas, it was specified that biological projects conducted in Rimeleh Area has turned more successful in terms of carbon sequestration.

In a nutshell, it can be concluded that total watershed management conducted in Rimeleh Area has been turned as a successful sample of biological activities in terms of carbon sequestration and total watershed operation conducted in aquifer can be considered as a successful sample of mechanical activities in terms of carbon sequestration.

REFERENCES

1. Ardo, J. L. Olsson. 2003. Assessment of soil organic carbon in semiarid Sudan using GIS and the CENTURY model. J. of Arid Environ. 2:83-99.
2. Derner, J.D. and Schuman, G.E., 2007. Carbon sequestration and rangelands: A synthesis of land management and precipitation effects, Journal of Soil and Water Conservation, 62: 2, 77-85.
3. Fang, S., Xue, J. and L. Tang. 2006. Biomass production and carbon sequestration potential in polar plantations with different management patterns. J. Environ. Manag. 85:672-679.
4. Grunzwieg, J.M., T. Lin, and A. Yakir. 2003. Carbon sequestration in arid land forest. Global Change Biol. 9: 791-799.
5. Henry, M., Besnard, A., Asante, W.A., Eshun, J., Adu-Bredu, S., Valentini, R., Bernoux, M and Saint-André, L., 2010. Wood density, phytomass variations within and among trees, and allometric equations in a tropical rainforest of Africa. Forest Ecology and Management 260: 1375–1388.
6. IPCC, 2000. Land-use, land-use change, and forestry. In: Watson, R.T., Noble, I.R., Bolin, B., Ravindranath, N.H., Verardo, D.J., Dokken, (Eds.). A Special Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK.
7. Lal, R. 2004. Soil carbon sequestration to mitigate climate change. Geoderma 123: 1 –22
8. Lal, R., 2008. The Role of Soil Organic Matter in the Global Carbon Cycle. Soil and Environ. Pollut. 116, 353–362.
9. Lashanizand,M., Veyskarami,I., Rafeei,B., and , Gholamreza Chamanpira. 2012..Evaluation the Efficiency of Watershed Management Mechanical Practices on Carbon Sequestration for Climate Change Mitigation. Soil Conservation and Watershed Management Research Institute, 01-22-8804-88006.
10. Law M.C., S.K. Balasundram, M.H.A. Husni, O.H. Ahmed and M.H. Harun. 2009. Spatial variability of soil organic carbon in oil palm. International J. of Soil Sci. ISSN. 1816-4978.
11. Liao J.D., T.W. Buton, and J.D. Jastraw. 2006. Storage and dynamic of carbon and nitrogen in soil physical fractions following woody plant invasion of grassland. Soil Biol. and Biochem. 38:3188-3198.
12. Liu D., Z. Wang, B. Zhang, K. Song, X. Li, J. Li, F. Li, and H. Duan. 2006. Spatial distribution of soil organic carbon and analysis of related factors in croplands of the black soil region, Northeast China. Agriculture, Ecosystems and Environment 113:73–81.
13. Liu S.L. X.D. Guo. B.J. Fue. 2007. The effects of environmental factors on soil characteristics at different scales in the transition zone of loess plateu in China. Soil Use and Manag.23-92-99.
14. Marshall, A.R., Willcock, S., Platts, P.J., Lovett, J.C.,Balmford, A., Burgess, N.D., Latham, J.E.,Munishi, P.K.T., Salter, R., Shirima, D.D. and Lewis, S.L., 2012. Measuring and odeling aboveground carbon and tree allometry along a tropical elevation gradient. Biological Conservation, Article in press.
15. Merino A. 2004. Responses of soil organic matter and greenhouse gas fluxes to soil management and land use changes in a humid temperate region of southern Europe. Soil Biology & Biochemistry. 36:917–925.
16. Povirk K.L., J.M. Welker G.F. Vance. 2001. Carbon sequestration in arctic Tundra and mountain meadow ecosystems, Lewis Publisher, Washington. Pp.189-228. soil. Soil Sci. Soc. Am. J. 52, 1114–1117.
17. Siahmansour, R., Arzani, H., Jafari, M., Javadi, S, A., and Ali Tavili., 2014. An investigation on the effect of fire on main particulars in woodland (Case study in Veysian – Lorestan), Bull. Env. Pharmacol. Life Sci., Vol 3 (4)March 2014: 192-199.
18. Su-Yong, Z. and Zhao, H. L. 2003. Influences of grazing and enclosure on carbon sequestration in degraded sandy grassland. Inner mongoha, north china, New Zealand Jour nal of Agricultural Research 46:4, 321 - 328.
19. Siahmansour, R., Arzani, H., Jafari, M., Javadi, S, A., and Ali Tavili., 2015. An investigation on the effect of fire on growth form and different class of palatability, Journal of Range and Watershed Management, Volume 68, No. 2. 517- 531.(in Persian).