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Effect of Land Use Change on Carbon Sequestration: A Case Study in Shahmirzad Walnut Orchad, Semnan, Iran

[1]M. Abdipour, [2]S.M. Hoseini, [1]H. Kaboli and [1]M. Kia Kianian
[1]Faculty of Desert Studies, Semnan University, Iran
[2]Department of Forestry, Tarbiat Modarres University, Iran

Corresponding Author: M. Kia Kianian, Faculty of Desert Studies, Semnan University, Iran

ABSTRACT

Climate change, which has negative effects on wet and dry ecosystem is one of the most important challenges in sustainable development. The increase of atmospheric Carbon dioxide is the main cause of this phenomenon. The mass of 20 year old walnut trees and adjacent rangeland (control) with overcoming coverage *Astragalus parrowianus* and *Acantolimon erinaceum* in the city of Shahmirzad of the Semnan province was chosen to study the effects of land use change on carbon sequestration. The sequestered atmospheric carbon dioxide was measured at biomass (aerial and underground), compost and soil (0-15 and 15-30 cm layers). The results show that in working unit one there were 116.54 t ha^{-1} of sequestered carbon in the orchard and 74.58 t ha^{-1} in the rangeland. In working unit two there were 130.15 t ha^{-1} in the orchard and 71.305 t ha^{-1} in the rangeland. This caused carbon sequestration to rise by 41.69 t ha^{-1} in working unit one and 58.845 t ha^{-1} in working unit two. Walnut tree aerial biomass had the most Carbon sequestration. The most important factors affecting the soil's organic carbon were organic material content, Ec and percentage of silt and sand. There were meaningful and positive relations between the soil's organic carbon and organic material in soil. The results show that the land use change had a significant effect in raising the total carbon sequestration in the region.

Key words: Climate change, carbon sequestration, land-use change, biomass, soil, shahmirzad walnut orchard, Iran

INTRODUCTION

During the past two centuries global industrialization has lead increased concentration of greenhouse gases. Concerns about the amount of Carbon emissions in the atmosphere and their effects on the environment were increasing everyday. In 1992 as a result of these concerns almost all the countries in the word including Iran signed the United Nations Framework Convention on Climate Change (UNFCCC). The long term objective of the treaty is based on agendum to stabilize greenhouse gas concentrations in the atmosphere to an acceptable level. The treaty also forecasted that there would be some costs for research and study on this subject in the participating countries. Subsequently in 1997, the Kyoto Protocol was approved by most of the developed industrial countries, which for these countries sets binding obligations to find ways to equilibrate atmospheric greenhouse gases. The Kyoto Protocol bound the industrial countries, which were adding most of the greenhouse gases to the atmosphere, to reduce these gases including Carbon dioxide. The Islamic Republic of Iran although it is not considered one of the industrial countries, due to the production of oil and oil byproducts is major part of the country's export and Gross National Product

(GNP), could be claim has significant indirect contribution to greenhouse gas emissions (Varamesh *et al*., 2008). Therefore to reduce atmospheric CO_2 and create balance between the elements of the greenhouse gases the existing atmospheric Carbon must be captured and stored in one or multiple forms. The most simple and economic way for reducing the level of atmospheric CO_2 is carbon sequestration in plant biomass and soil (Abdi, 2005).

Polglase and Paule conducted studies related to effective factors which changing soil carbon sequestration in Australia and concluded that climate, type of plants and land fertility are effective on carbon sequestration. The studies show that in rangelands with tree coverage, replacing the trees (big and small) with bushes leads to decreased soil carbon storage. During a study on increasing atmospheric Carbon dioxide and the effect of land management on Carbon sequestration in rangelands, Rice (2000) recognized that soil Carbon sequestration up to depth of 15 cm in dry area rangelands is affected by the land management (Bruce *et al*., 1999; Singh *et al*., 2003).

The study conducted in a walnut orchard (experiment area) and adjacent rangeland (control area), about 700 ha each, located Northeast of Shahmirzad city in Semnan province at 53°23'N and 53°28'N latitudes and 35°43'E and 33°52'E longitude. Maximum and minimum elevation of the area is 2,900 and 2,300 m above sea level and the general slope is north south.

Abdi (2005) explains the relationship between carbon sequestration with percentage of plant coverage (vegetation), plant species, amount of compost, land use and land management. Also Lal (2005) believed that the ratio of carbon sequestration and volume and quality of carbon storage depends on actions and reactions between climate, soil, tree species, land management and chemical components of the compost.

Goal of the research is to study effect of land use change and effective elements on Carbon sequestration in rangeland (with dominant coverage of Astra Gallus parrowianus in working unit one and Acantolimon erinaceum in working unit two) and walnut orchard (*Juglans regia* L.).

MATERIALS AND METHODS

Study area: The study area is located in 53°23' to 53°28'N and 35°43' to 35°52'E. This garden is in Shahmirzad region in east northern of Semnan city (Fig. 1). The elevation is about 2600 ASL. Mean Rainfall amount is 239 mm, also the mean temperature is 20°C. The orchard was established in 1988 and belongs to the Shahmirzad Agro-Industry Corporation. In addition to planting 20,000 walnut and almond trees, the corporation also added plant fodder to the area. The coverage is important and significant due to the effects of plant coverage and green landscape on climate, air quality and scenic view of the city (Fig. 1).

Sampling: To reduce side effects, samples were taken from areas close to the center of the orchard and some distance from the orchard and rangeland margins. After a preliminary site visit and establishment of the study area systematic random sampling was used to study the specified variables. Six parallel transects were established at the rangeland and also 10 one square meter plats were placed aligned to each transect. The first transect location was chosen randomly and by considering the total zone area an additional 5 transects were established in specific distance from each other. The orchard trees were planted in a pattern, the tree sampling was done by randomly choosing a tree in a row and then another tree every other 5th row. It should be mentioned that due to having two different land uses, it specified that two working units in each area (based on slope, plant type and using GIS).

(a)

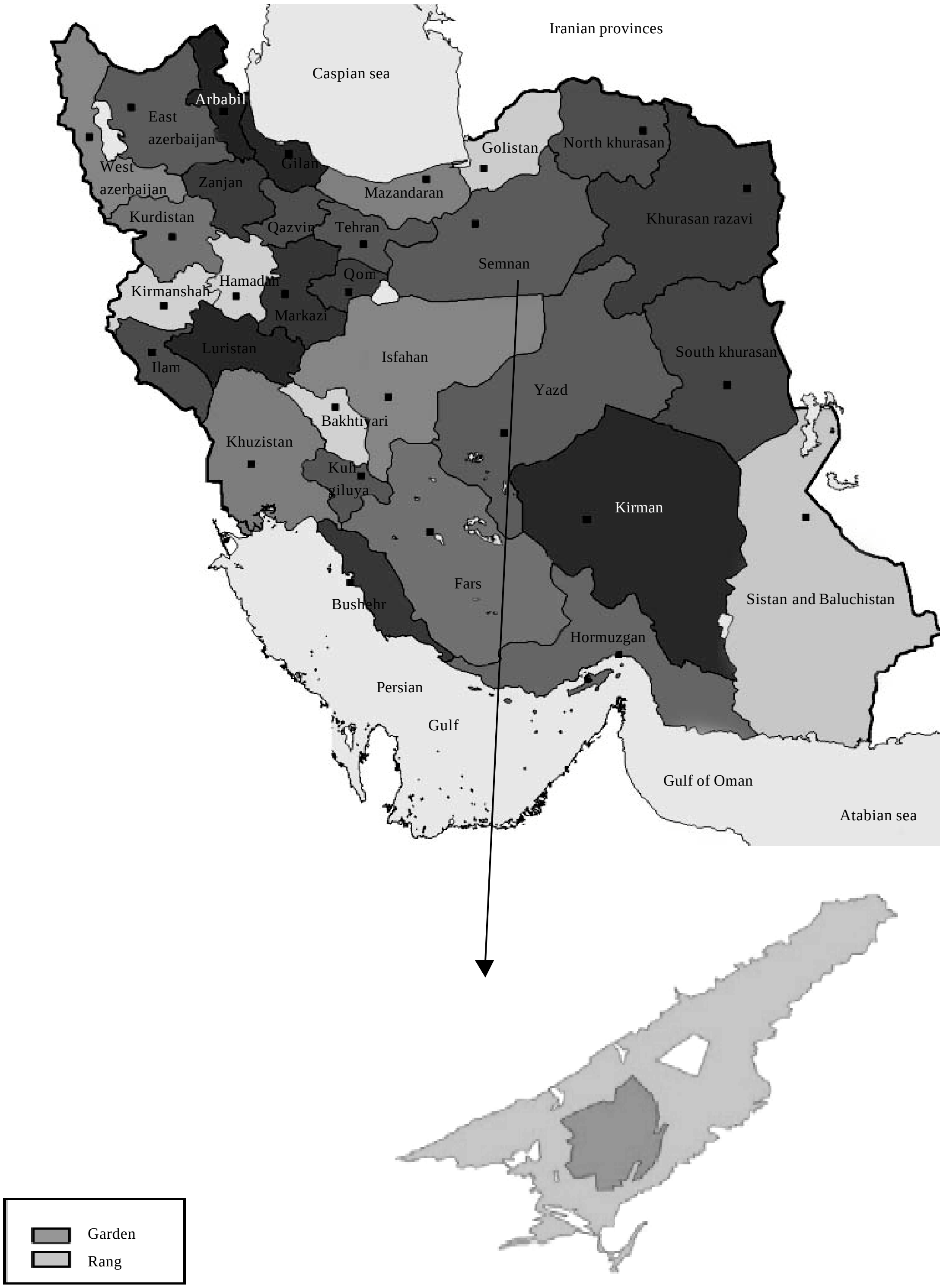

Fig. 1(a-b): Continue

(b)

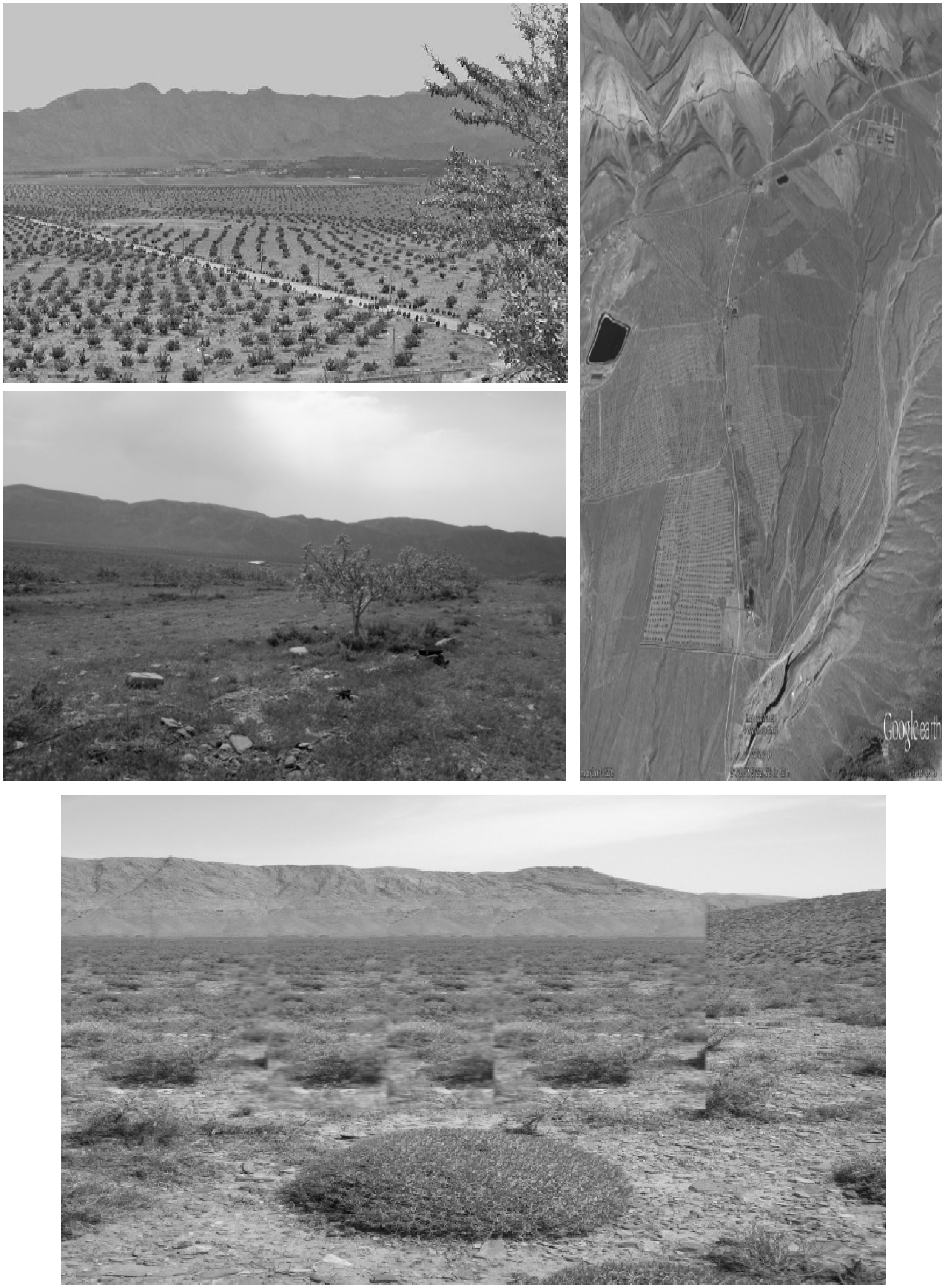

Fig. 1(a-b): (a) Study area map and (b) Picture

In the rangeland for each plat a list of the existing plant species and population percentage was prepared. Then a double sampling method was used to measure the mass of the aerial part of dominant species. Mass of other species were measured based on cut and weight. Direct sampling method used to gather data about the weight of the compost. Also in all plats the percentage of dominant and companion plants, plant density, perimeter of the cover crown and plant height were measured (Rangeland evaluation plan in Iran's different climates, Research Institute of forests and rangelands).

Soil samples were gathered by removing the compost and digging a trench along the length of each transects. Samples were taken from depth of 0-15 and 15-30 cm, since deeper than 30 cm organic carbon in soil is insignificant and has no meaningful increase. Compound method was used for sampling to minimize the errors. In each plats 5 soil samples were taken from the four corners and center, then all the samples of each depth were mixed and 6 samples, about 1,000 g each, from the mixture were put in plastic bags and transported to the lab.

In the orchard one tree was chosen randomly in each application (base on having two applications), then for that tree and the trees on all four sides of it all the necessary parameters were measured. The same method was used for each tree at every other 5th row. Tree characteristics such as Diameter at Breast Height (DBH), height, trunk height and minimum and maximum crown diameter were measured. All branches in the tree's crown were cut and the weighted by a sensitive scale. Due to unstable and insignificant carbon levels in the leaves, leaf samples were not taken. The samples were transported to the lab in plastic bags (MacDicken, 1997; Losi *et al.*, 2003; Ponce-Hernandez *et al.*, 2004; Redondo-Brenes, 2007; Varamesh, 2009).

First all of the trunk, branch and compost samples were dried in an oven at 105°C for 24 h. The percentage of Organic Carbon in samples was measured by electric combustion furnace method. Percentage of sand, silt and soil texture by Bikash hydrometer method, bulk density by clod method, PH of saturated mud by potentiometer, Electro conductivity (Ec) of saturated mud extract, Organic carbon by Valki and Black method and nitrogen by Kjeldahl method were measured in soil samples.

Carbon sequestration in grams per square meter was calculated by using following equation:

$$Cs = 100 \times OC\,(\%) \times Bd \times e$$

Where:

Cs = Organic Carbon ($g\ m^{-2}$)
OC = Organic carbon percentage
Bd = Soil bulk density ($g\ cm^{-3}$)
e = Depth of sampling (cm)

Biomass calculation method: First the cross area of the tree trunk was calculated by Eq. 1. Aerial biomass calculated by Allometric method (Eq. 2) (Segura *et al.*, 2006):

$$Ab = \pi \times r^2 \quad (1)$$

Where:

Ab = Tree's cross area (m^2)
π = 3.14
r = Tree's radius (m)

$$\text{Log } Y = a+b\times\text{Log DBH} \quad (2)$$

Where:
a, b = Equation's factors
DBH = Diameter at breast height (cm)

Taking tree root samples for biomass calculation is a time consuming effort and has a high cost. To avoid destructive root sampling, Eq. 3 was used to calculate the root biomes:

$$\text{BGB} = \text{AGB volume}\times 0.2 \quad (3)$$

Where:
BGB = Below ground biomass
AGB = Above ground biomass (Aerial Biomass)

Crown volume of broadleaf tree (walnut) calculated by Eq. 4:

$$V(m^3) = (\pi\times Db^2)/12 \quad (4)$$

Where:
Db = (L+W)/2
π = 3.14

Data analysis and processing: An Excel sheet was used to store the data and then normality of the samples was tested by Kolmogorov- Smirnov method and Levene test was used for equality of variances. Analysis of variance between groups (ANOVA) was used for general comparison of the groups. Linear correlation between the amount of organic carbon in soil and other factors were measured by a Pearson product-moment correlation coefficient. A linear regression analysis was used to find the most effective soil factor affecting the soil carbon sequestration. Figures provided by Excel.

RESULTS

Carbon sequestration in aerial and underground biomass data showed that the amount of sequestration in orchard trees aerial organs, roots and compost were more than the adjacent rangeland. Carbon in total biomass does not show meaningful differences with any of the measured elements (Fig. 2).

The data also showed that there is a meaningful difference ($p<0.05$) between the amounts of aerial biomass. The walnut orchard in both applications has more aerial biomass than the rangeland (Fig. 3).

Pearson product-moment correlation coefficient results showed that there is a positive and meaningful relationship between the total biomass carbon and underground biomass ($p<0.05$), aerial biomass, aerial biomass carbon, underground biomass carbon and total biomass ($p<0.05$) (Table 1).

The data analysis showed that during last 24 years, planting walnut trees in Shahmirzad orchard did not have significant effects on soil carbon sequestration but a trend of change in carbon

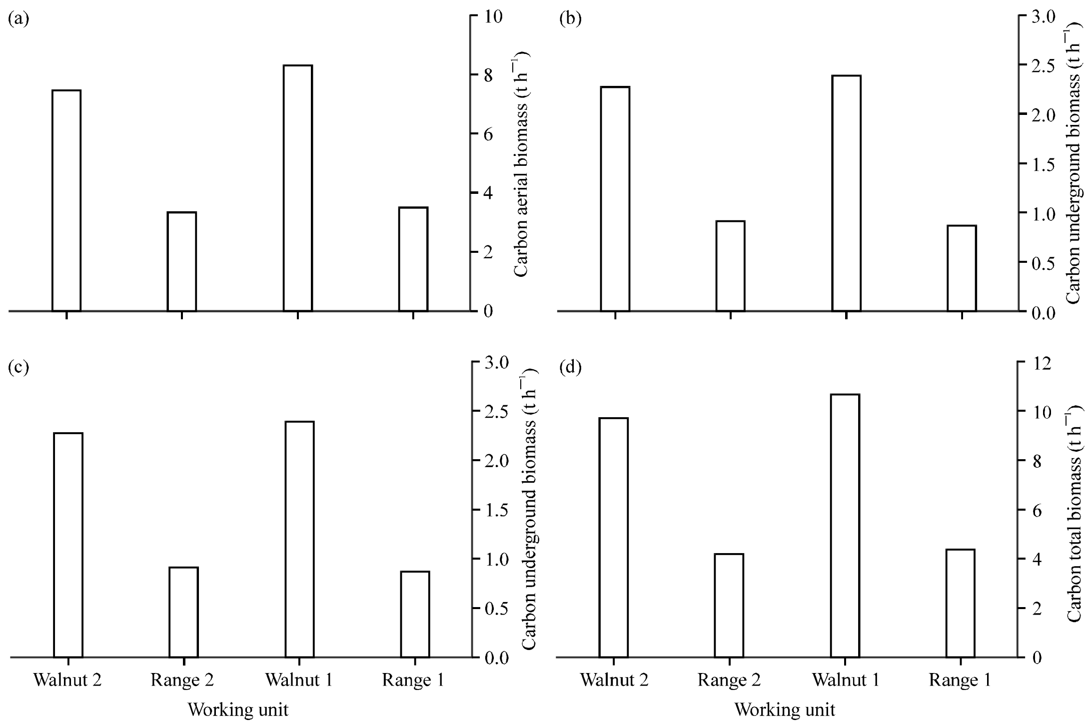

Fig. 2(a-d): Carbon sequestration in (a) Aerial biomass, (b) Underground, (c) Compost and (d) Carbon total biomass in rangeland's working unit one with *Astragalus parrowianus* as dominant vegetation and adjacent walnut orchard and rangeland's working unit two with *Acantolimon erinaceum* as dominant vegetation and adjacent walnut orchard in Shahmirzad

Table 1: Correlation coefficient breakdown between measured properties of biomass carbon in rangeland's working unit one with *Astragalus parrowianus* as dominant vegetation and adjacent walnut orchard and rangeland's working unit two with *Acantolimon erinaceum* as dominant vegetation and adjacent walnut orchard in Shahmirzad

Parameters	Above ground biomass	Under ground biomass	Carbon above ground biomass	Carbon under ground biomass	Total biomass	Biomass
Above ground biomass						
Under ground biomass	0.982*					
Carbon above ground biomass	1.000**	0.982*				
Carbon under ground biomass	1.000**	0.986*	0.999**			
Total biomass	0.999**	0.991**	0.998**	0.999**		
Carbon total biomass	1.000**	0.983*	1.000**	0.999**	0.999**	

*, **Respectively show the significant at the 0.05 and 0.001 level

content is obvious in this land use change. The maximum amount of organic carbon in soil was in 0-15 cm depth in the orchard's working unit two. The minimum amount was in 15-30 cm depth in the rangeland's working unit two (Fig. 4). Total carbon sequestrations at working unit one at the orchard (case area) were 60.31 and 73.98 t ha^{-1}. At the rangeland (control area) they were 67.50 and 64.15 t ha^{-1} at working unit one and two, respectively. So land use change caused a soil carbon reduction of 7.16 t ha^{-1} in working unit one and a soil carbon increase of 9.83 t ha^{-1} at working unit two (Fig. 5).

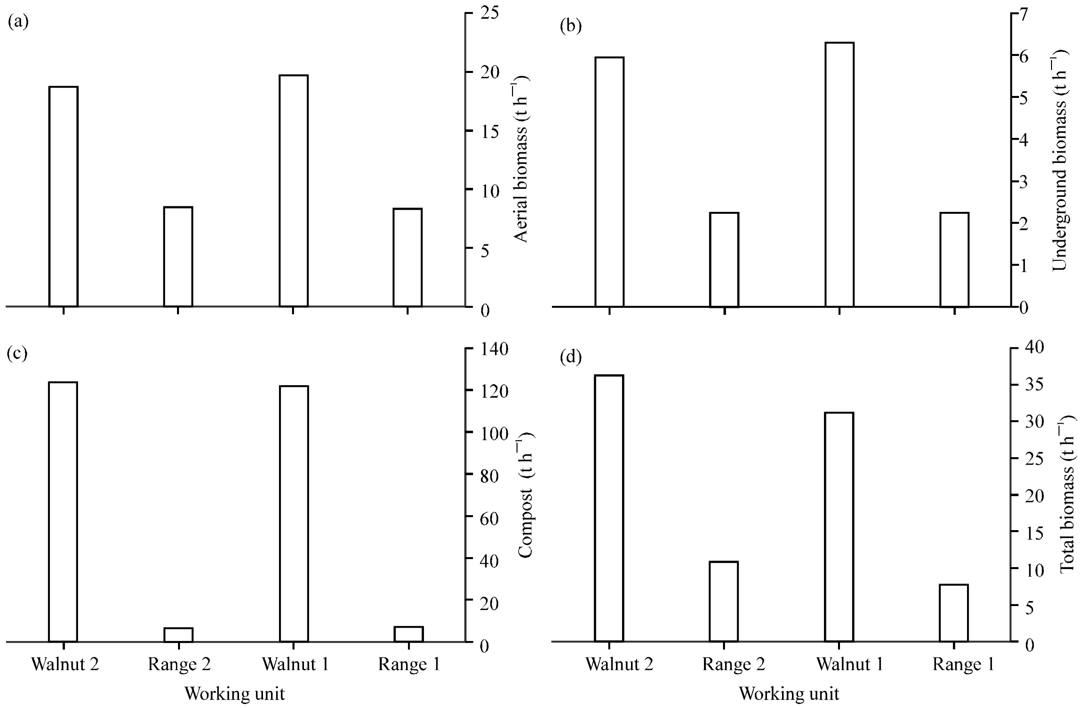

Fig. 3(a-d): Comparison between qualitative properties, (a) Aerial biomass, (b) Underground biomass, (c) Compost and (d) Total biomass in rangeland's working unit one with *Astragalus parrowianus* as dominant vegetation and adjacent walnut orchard and rangeland's working unit two with *Acantolimon erinaceu*m as dominant vegetation and adjacent walnut orchard in Shahmirzad

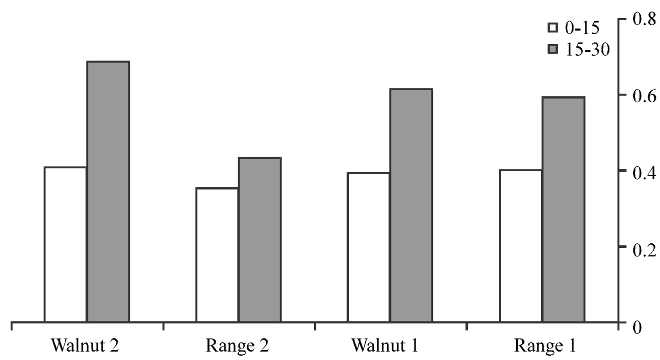

Fig. 4: Soil organic carbon percentage in 0-15 and 15-30 cm depth in rangeland's working unit one with *Astragalus parrowianus* as dominant vegetation and adjacent walnut orchard and rangeland's working unit two with *Acantolimon erinaceum* as dominant vegetation and adjacent walnut orchard in Shahmirzad

Based on the study results, total carbon sequestration in each of the working units was as follows: Total carbon sequestration at working unit one of the rangeland was 74.85 t ha^{-1}, the sequestration was 67.50 t ha^{-1} 90% in soil, 4.45 t ha^{-1} 6% in total biomass and 2.9 t ha^{-1} (4%) in compost. The total carbon sequestration at orchard's working unit one was 116.54 t ha^{-1}, from

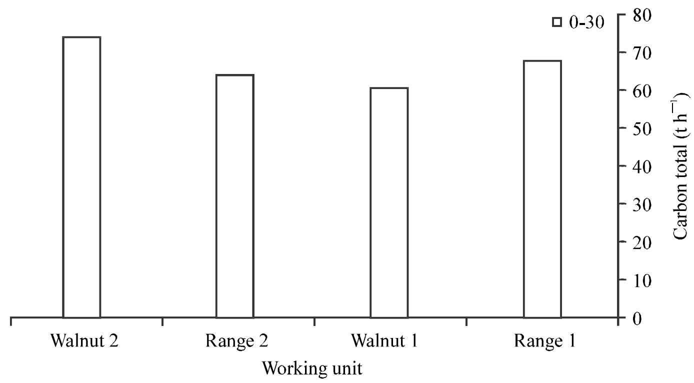

Fig. 5: Total soil carbon sequestration in rangeland's working unit one with *Astragalus parrowianus* as dominant vegetation and adjacent walnut orchard and rangeland's working unit two with *Acantolimon erinaceum* as dominant vegetation and adjacent walnut orchard in Shahmirzad

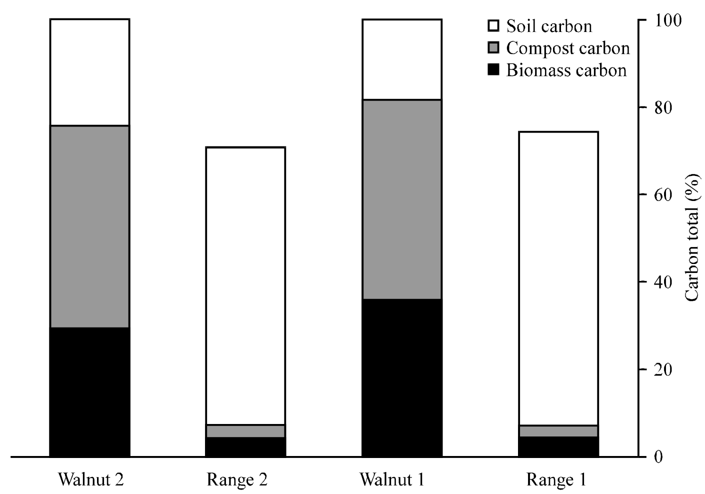

Fig. 6: Sequestered Carbon distribution manner in different components in each working unit

which soil, total biomass and compost carbon sequestration were 60.31 t ha^{-1} 42%, 36.74 t ha^{-1} 26% and 45.53 t ha^{-1} (32%), respectively. Total carbon sequestration at working unit two was 71.305 t ha^{-1}, the percentage of sequestration was 64.15 t ha^{-1} 90% in soil, 4.27 t ha^{-1} in total biomass and 2.88 t ha^{-1} (4%) in compost. Total carbon sequestration at orchard's working unit two was 130.15 t ha^{-1}, the sequestration was 73.98 t ha^{-1} 47% in soil, 35.45 t ha^{-1} 23% in total biomass and 46.07 t ha^{-1} (30%) in compost (Fig. 6).

DISCUSSION

The results show that land use change from rangeland to orchard will have a very high potential for atmospheric carbon sequestration. Since the amount of soil carbon had a significant increase in each of the working units of orchard in comparison to rangeland. Land use change from rangeland to orchard increased the amount of carbon from 74.85 to 116.54 t ha^{-1} in working unit one and from 71.305 to 130.15 t ha^{-1} in working unit two. A significant number of studies such as

Lemma *et al.* (2006), Redondo-Brenes (2007), Lal (2008), Dube *et al.* (2009) and Fensham and Guymer (2009) indicated the positive effect of foresting in atmospheric carbon sequestration. Planting fast growing trees and developing secondary forests (rebuilding and restoring) is very effective on carbon sequestration (Laclau, 2003).

Also the study shows that forest restoration by suitable species in unutilized land and ruined rangeland at suburb of metropolitan cities like Tehran, in semiarid climate has a high potential for atmospheric carbon sequestration (Varamesh, 2009). Thus mass of Tehran pine, ash-tree, silver cypress and locust trees leading to an increase of 514.2, 139.9, 317.4 and 482.55 t ha^{-1} carbon sequestration respectively in comparison to the surrounded ruined rangeland. Biomass increase was the most effective factor on additional carbon sequestration in the study, while soil carbon change was not significant and statistically meaningful which can be related to soil carbon wash out by erosion.

Although, study reports regarding the effect of forest restoration on increasing Soil Organic Carbon (SOC) are contradictory. For instance some studies show that indeed the total stored SOC decreased by forestation (Turner and Lambert, 2000; Neufeldt *et al.*, 2002).

In this study we tried to have the same bedrock and topography in all different land uses. Some of the researchers believe that if the soil properties were different in the soil stands, the results of carbon storage will be different (Crews *et al.*, 1995; Yanai *et al.*, 2003). Therefore using soil masses by similar bedrock, soil type, topography and past land use could reduce the errors.

Results showed that in both working areas the first layer of soil (0-15 cm depth) had more carbon percentage in comparison to the next layer (15-30 cm depth).

The Varamesh *et al.* (2008) research showed that in a mass of forested area, the percentage of carbon in first soil layer (0-15 cm) was greater than of second layer (15-30 cm). A previous research also showed that usually most of the organic material is stored in the soil surface and decreases by depth.

The results showed that the amounts of sequestered carbon in biomass in both working units at orchard were more than the rangeland, which can be related to tree's high biomass production. Related to this subject, Hoover *et al.* (2000) believed that stands with higher biomass content hold more carbon per unit area.

Considering the carbon sequestration in compost and soil is due to carbon sequestration in vegetation and through carbon cycle the existing carbon in vegetation texture converts to the compost and soil carbon, therefore study of carbon sequestration in vegetation has more priority. Most of the methods for estimating carbon sequestration are based on biomass measurement, because biomass and plant's carbon content has the most correlation and the plant's carbon is a part of biomass (Varamesh, 2009).

Total biomass carbon distribution showed that carbon stock in the plant's aerial parts is more than roots which concurs with the results of Aradottir *et al.* (2000) and Abdi (2005) studies. Also during forest stand's lifetime, biomass share in the tree's carbon stock changes (Satoo and Madgwick, 1982). In this study the highest carbon sequestration in compost happened at compost of orchard's working unit two, about 46.07 t ha^{-1}. This can be related to the low percent of decomposition and the favorable condition of the rangeland at orchard floor (IPCC., 2000).

The highest amount of biomass and roots carbon in this study was also in the orchard's working unit one, about 6.3 and 2.4 t ha^{-1}, respectively. Roots are one of the most important components of a forest's carbon sequestration (Laclau, 2003). Root's biomass, 10-40% of the total biomass is considered as an important source of carbon but root's carbon evaluation is very expensive. Studies show that most of the times the real amount of root biomass in direct measurements are higher than the conservative estimates. The decision for roots biomass direct measurement or estimate is based on study goals and sampling costs, in economic carbon sequestration projects the decision is based on value of carbon in comparison to direct sampling costs (MacDicken, 1997).

Different plant species have different potential for carbon sequestration. A Gaykani (2010) study of four plant types showed that between these four types the Atriplex verrucifera had the most amount of carbon sequestration with an average of 30.17 t ha^{-1} although this type of plant had less total biomass in comparison with other three types, which could be related to amount of soil's organic carbon.

CONCLUSION

The increase of atmospheric Carbon dioxide is the main cause of Climate change. The mass of 20 year old walnut trees and adjacent rangeland (control) with overcoming coverage *Astragalus parrowianus* and *Acantolimon erinaceum* in the city of Shahmirzad of the Semnan province was chosen to study the effects of land use change on carbon sequestration. The sequestered atmospheric carbon dioxide was measured at biomass (aerial and underground), compost and soil (0-15 and 15-30 cm layers). The results show that in working unit one there were 116.54 t ha^{-1} of sequestered carbon in the orchard and 74.58 t ha^{-1} in the rangeland. In working unit two there were 130.15 t ha^{-1} in the orchard and 71.305 t ha^{-1} in the rangeland. This caused carbon sequestration to rise by 41.69 t ha^{-1} in working unit one and 58.845 t ha^{-1} in working unit two. Walnut tree aerial biomass had the most Carbon sequestration. The most important factors affecting the soil's organic carbon were organic material content, Ec and percentage of silt and sand. There were meaningful and positive relations between the soil's organic carbon and organic material in soil. The results show that the land use change had a significant effect in raising the total carbon sequestration in the region. Also, we need to sequestration Carbon by planting different kinds of plants for Iranian desert areas.

REFERENCES

Abdi, N., 2005. Estimation of carbon sequestration capacity by *Astragalus* genus (subgenus *Tragacantha*) in Markazi and Isfahan provinces. Ph.D. Thesis, Department of Rangeland Sciences, Islamic Azad University, Tehran, Iran.

Aradottir, A.L., K. Svavarsdottir, T.H. Jonsson and G. Gudbergsson, 2000. Carbon accumulation in vegetation and soils by reclamation of degraded areas. Icelandic Agric. Sci., 13: 99-113.

Bruce, J.P., M. Frome, E. Haites, H. Janzen, R. Lal and K. Paustian, 1999. Carbon sequestration in soils. J. Soil Water Conserv., 54: 382-389.

Crews, T.E., K. Kitayama, J.H. Fownes, R.H. Riley, D.A. Herbert, D. Mueller-Dombois and P.M. Vitousek, 1995. Changes in soil phosphorus fractions and ecosystem dynamics across a long chronosequence in Hawaii. Ecology, 76: 1407-1424.

Dube, F., E. Zagal, N. Stolpe and M. Espinosa, 2009. The influence of land-use change on the organic carbon distribution and microbial respiration in a volcanic soil of the Chilean Patagonia. For. Ecol. Manage., 257: 1695-1704.

Fensham, R.J. and G.P. Guymer, 2009. Carbon accumulation through ecosystem recovery. Environ. Sci. Policy, 12: 367-372.

Gaykani, S., 2010. Investigation of land use and management on co2 sequestration rate in west northern of Mighan playa. M.Sc.Thesis, Islamic Azad University of Arak, Iran.

Hoover, C.M., R.A. Birdsey, L.S. Heath and S.L. Stout, 2000. How to estimate carbon sequestration on small forest tracts. J. Forestry, 98: 13-19.

IPCC., 2000. The Intergovernmental Panel on Climate Change: Special Report on Land Use, Land Use Change and Forestry. Cambridge University Press, Cambridge, UK.

Laclau, P., 2003. Biomass and carbon sequestration of ponderosa pine plantations and native cypress forests in northwest Patagonia. For. Ecol. Manage., 180: 317-333.

Lal, R., 2005. Forest soils and carbon sequestration. For. Ecol. Manage., 220: 242-258.

Lal, R., 2008. Carbon sequestration. Philos Trans. R. Soc. Lond. B: Biol. Sci., 363: 815-830.

Lemma, B., D.B. Kleja, I. Nilsson and M. Olsson, 2006. Soil carbon sequestration under different exotic tree species in the southwestern highlands of Ethiopia. Geoderma, 136: 886-898.

Losi, C.J., T.G. Siccama, R. Condit and J.E. Morales, 2003. Analysis of alternative methods for estimating carbon stock in young tropical plantations. For. Ecol. Manage., 184: 355-368.

MacDicken, K.G., 1997. A guide to monitoring carbon storage in forestry and agro forestry projects. Winrock International Institute for Agricultural Development, Forest Carbon Monitoring Program, pp: 91.

Neufeldt, H., D.V. Resck and M.A. Ayarza, 2002. Texture and land-use effects on soil organic matter in Cerrado Oxisols, Central Brazil. Geoderma, 107: 151-164.

Ponce-Hernandez, R., P. Koohafkan and J. Antoine, 2004. Assessing Carbon Stocks and Modelling Win-win Scenarios of Carbon Sequestration Through Land-use Changes, Volume 1. Food and Agriculture Organization, USA., ISBN: 9789251051580, Pages: 156.

Redondo-Brenes, A., 2007. Growth, carbon sequestration and management of native tree plantations in humid regions of Costa Rica. New Forests, 34: 253-268.

Rice, C.W., 2000. Soil organic C and N in rangeland soils under elevation co2 and land management. Proceedings of the Advances in Terrestrial Ecosystem Carbon Inventory, Measurements and Monitoring Conference, October 3-5, 2000, Raleigh, North Carolina, pp: 15-24.

Satoo, T. and H.A.I. Madgwick, 1982. Forest Biomass. M. Nijhoff/Dr.W. Junk Publishers, Boston, Pages: 152.

Segura, M., M. Kanninen and D. Suarez, 2006. Allometric models for estimating aboveground biomass of shade trees and coffee bushes grown together. Agroforestry Syst., 68: 143-150.

Singh, G., N. Bala, K.K. Chaudhuri and R.L. Meena, 2003. Carbon sequestration potential of common access resources in arid and semi-arid regions of northwestern India. Indian Forester, 129: 859-864.

Turner, J. and M. Lambert, 2000. Change in organic carbon in forest plantation soils in eastern Australia. For. Ecol. Manage., 133: 231-247.

Varamesh, S., 2009. Effectuality of forestation on soil carbon sequestration and mitigate climate change. Proceedings of the 1st International Conference of the World Soil Erosion and Conservation, May 27-30, 2009, Tara Mountain, Serbia.

Varamesh, S., S.M. Hosseini and N. Abdi, 2008. Potential of urban forest to reduce the greenhouse gases and energy preservation. J. Energy New Comes, 1: 71-72.

Yanai, R.D., W.S. Currie and C.L. Goodale, 2003. Soil carbon dynamics after forest harvest: An ecosystem paradigm reconsidered. Ecosystems, 6: 197-212.