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STUDY INTO CERTAIN SOIL DEGRADATION INDICES IN DRY FARMING AND DITCH FARMING LAND USE IN GHALEH GORG REGION, SHUSHTAR

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ABSTRACT
Growth of human population has raised expectations regarding living standards, and scarcity of natural resources, due to its numerous threats to human life, has turned soil degradation into a main topic in today's modern era. Past agricultural management, in combination with soil ecosystems aimed at meeting human population demands, has exerted huge pressure on soil capacity as well as environmental functions to maintain the universal balance between matter and energy. Iran's being located in the arid and semi-arid belt of the world as well as the occurrence of droughts and devastating floods on the one hand, and population increase and efforts to sustain food security on the other, have contributed in turning soil degradation into a major problem in the country. Land use change and the consequent land desertification combined with population increase would inevitably eternalize problems such as poverty and deprivation. Due to the significance of this subject, focused study of certain soil degradation indices in two cases of Dry farming and Ditch Farming was put on the agenda. Some experts believe parameters related to physical properties of soil including apparent soil bulk density and porosity, as well as chemical parameters, fertility, and organic materials play a role in soil degradation. The obtained results showed that as compared with ditches, agricultural land possessed higher amounts of organic carbon, and no significant difference was observed between agricultural and ditch farming in terms of apparent soil bulk density or porosity. In the present study, the experimental results showed that mean organic carbon content is equal to 0.23% in dry agricultural lands while the former is equal to 0.09% in gullies. Dry lands had statistically significantly higher organic carbon compared to gullies. The mean index of bulk density in dry land was calculated as 1.6 while the index was calculated as 1.49 in gullies. Mean porosity index was calculated as 0.39 in dry land while the index was calculated as 0.04 in gullies. No statistical significant difference was observed between soils in agricultural lands and gullies in term of bulk density and porosity.

KEY WORDS: ditch, dry farming, land use/occupancy, Soil degradation.

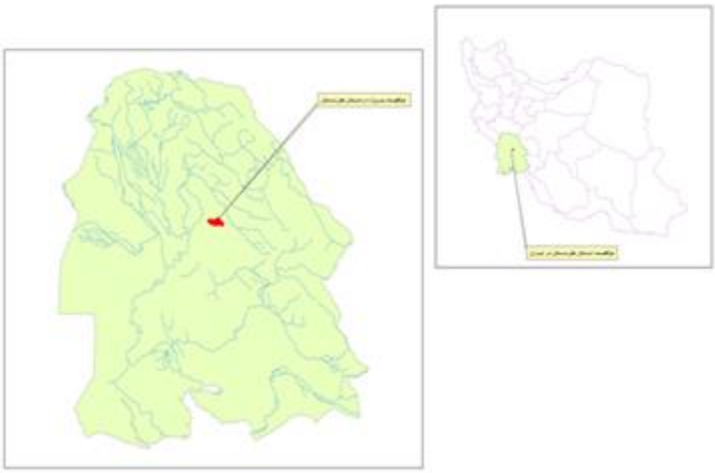
INTRODUCTION
Hazy skies, muddy waters flowing in vast expanding fields, and fever-stricken deserts, all convey the same message: The imminent death of soil. Civilizations began with soil fertility and sustainability, and could end with soil degradation and erosion (Ahmadi Ilakhchi *et al.,*2002*).*Population increase as well as higher living standards leads to a growing demand for food, clothing, and housing. As the mainstream resources for food and clothing requirements, soil resources have a prominent place in the economy and food security of all the nations in the world. Soil degradation resulting from such factors as improper use of agricultural land, land use change, rapid population growth, land utilizers' poor scientific/technical background, etc, has in turn lead to degradation of ecosystem followed by adverse changes in the physical and chemical properties of soil. The term "soil degradation" is defined as deterioration of soil quality resulting from improper use of soil by man. Soil degradation is the potential or actual loss of soil fertility, Ditch (gully) is defined as a canal with steep sloping sides and a sloped active erosion face resulting from erosion caused by alternate surface flows (usually during or after heavy rainfall) (Bear et al.,1994).One major objective of sustainable land management lies in identification of those management plans, which not only improve both quality and quantity of production in the long term, but also maintain soil quality and prevent soil and land degradation (Hernández *et al.*, 2007). It is essential to greatly consider and conduct many studies on soil quality due to severe land degradation in Iran

compared to the rest of the world (Azarabin *et al.*, 2003). Land use change and subsequent land desertification in long perspective lead to steady decline across every part of the plantation. Thus, such problems as poverty are worsened and eternalized (Chen and Zhu, 2004). One main objective of sustainable land management lies in identification of those management plans, which not only improve both quality and quantity of production in long term, but also prevent land degradation (Islam *et al.*, 1999). A living system within ecosystem is under different uses. As a result, not only biological productivity is maintained, but also water and air quality is improved. In addition, human, plant and animal health is preserved (Carter *et al.*, 2007). If soil management commensurate with soil condition is not practiced, soil productivity may decline for a long time (Haj Abbasi *et al.*, 2002). Nowadays, all researchers within the country believe that land use change is considered as one important factor, which may lead to hazardous changes in soil properties. Most studies conducted on water erosion investigated surface erosion (tracks and between tracks) in various lands. Many studies were conducted on surface plots. On the other hand, gully erosion is considerably important. Gully erosion is mostly observed in arid and semi-arid lands and non-susceptible land to any form of agriculture or in heterogeneous soil due to chemical and physical properties and little yield (Ghadiri, 1989). However, this type of erosion occurs in high-grade agricultural lands due to poor management. Iranian gullies are mostly observed in semi-arid and arid desert climates, dry lands, pastures and irrigated agriculture according to preliminary results of national plan of "morpho-climactic classification of gullies in Iran" (Sufi, 2003).

MATERIALS AND METHODS

The Studied Area Position

The Ghaleh Gorg region forms a part of the great Shushtar Shahid Modarres catchment area covering an area of 56.327 ha. The geographical coordinates of this catchment area are longitude 316536-331131 east and latitude 3510331-3518672 north. The highest and lowest altitudes in the region are 570 and 35 meters from sea level respectively. The Ghaleh Gorg area comprises of two regions: a mountainous region consisting of hills and valleys, and a relatively flat area. Slope of land is greater than 30 percent in approximately 2%, 20-30 percent in 4.2%, and less than 8% in 84 present of the area. This study was conducted on that part of land with a natural potential for being utilized as pasture. Parts of this land were turned into dry farm land. At the downstream of agricultural lands, ditches have been formed which have consequently turned into bad land in some parts.



map1:position of studied area in Khozestan Province in Iran

Zone Climatic Condition

Accordingly, maximum annual rainfall was estimated as 363.7 mm while the minimum annual rainfall was estimated as 275 mm. The average annual rainfall in the basin of Ghale Gorg was estimated as 310.3-mm. Rainfall distribution was also studied in these stations during different seasons. As a result, winter rainfall was 54.4% while autumn rainfall was 32.6% and spring rainfall was 13% in the study area. In this region, monthly fluctuation in temperature was from 12.2 degrees in January to 36.3 degrees in July and August. Maximum absolute temperature was 51.6°C in August while minimum absolute temperature was -4.2°C in February.

Geological and Geomorphological Characteristics

The formations in study area were studied in geological terms. A summary of each report is as follows. Aghajari Formation consists of brown to gray sandstone, marl and silt stone. Quaternary deposits: these deposits are the youngest sediments in the basin and consist of on forming formations, riverine alluvial deposits and flood plain sediments, percentage and area of each formation.

Table (1) amount of coverage in each formation in basin of Ghale Gorg

Title	Quaternary deposits	Aghajari Formation
Area (hectare)	563. 3578	888. 2748
Coverage percentage	56. 56	4. 43

Vegetation Condition in the Study Area

Based on studies conducted in the basin of Ghale Gorg, 106 plant species were identified in which 55 annual and 51 perennial species existed. Total area of the basin under study was 44. 6327 hectares. Different land uses were as follows: pastureland area was 19. 4938 hectares, which covers 78% of the basin. Agricultural land area was 25. 1389 hectares, which covers 22% of the basin.

Soil Studies

Field studies on soil moisture and thermal regimes. Both thermal and moisture regimes depend on climate; however, moisture regime depends on topography. In addition, moisture regime can be used to determine time of planting and harvesting various products. This can be particularly considered as an effective factor in management plans in dry land farming. Moisture regime not only depends on climate, but also soil permeability and depth. Thus, rainfall distribution is an important factor in determining the regime. The soil in arid climate is not necessarily dry. On the other hand, the soil in dry land may be dry or wet depending on topography. This is because lowlands can maintain highland sewage. According to studies, Ghale Gorg Area has Ustic moisture regime. The moisture regime is intermediate between Uridic and Udic, which indicates lack of soil moisture in growth periods. The mean soil temperature was more than 22°C, while the soil temperature difference in summer at 50 cm depth of was less than 5°C. The soil moisture control section is dry for 90 consecutive days in most years. Soil thermal regime is one important factor in formation of soil and relevant properties. Root growth and soil biological activity is highly dependent on temperature. All biological activities stop at a temperature less than 5°C. Plant germination and desirable growth occur at a temperature above 24°C. Different horizons have different temperatures. In addition, soil temperature fluctuations are represented as different curves in daily and annual terms.

Method

Ten random soil samples (each sample weighing approx. 2 kg) were extracted from a depth of 0-30 cm from the natural pasture and dry farming lands. The samples were then air-dried, beaten, and sifted through the mesh (size 10). Subsequently, in observance of expert recommendations in the field, we had the samples transferred to Maroun Khak Sabz Laboratory in Behbahan, Khuzestan Province, so that certain characteristic parameters, apparent bulk density, porosity, and organic content of the soil samples could be measured prior to evaluating the status quo of soil degradation.

Laboratory procedures

Studying soil properties and capability in Ghale Gorg Area require data collection, baseline data evaluation, conducting preliminary studies, completing field investigations, sampling and analysis of soil samples. All these steps were carried out respectively. Then, the region was identified and evaluated. Then, field data was examined and adjusted with various topographic, geological and geomorphological maps based on available land data. Then, sampling location was determined and visited. Then, sampling procedures were conducted. Then, the collected data was transferred to the laboratory for physical and chemical analysis. First, each sample taken from different land uses (except those related to soil bulk density) was air-dried and beaten. Particles smaller than 2 mm were separated using No. 10 sieve. According to several researchers, such parameters as soil physical properties including soil bulk density and soil porosity and those parameters associated with fertility and depletion of soil nutrients including %O. M (organic matter) were determined in order to assess soil degradation status in different land uses. The samples were transferred to the laboratory for analysis. At least this essay was translated by the web (www.worldtranslators.net).

Determining bulk density of soil samples

Bulk density is defined as the dry weight of soil per unit volume of soil in an electric oven. The unit is usually expressed in grams per cubic centimetre. Bulk density varies depending on construction, expansion, and contraction of clays. In this study, soil bulk density was determined using intact samples by metal cylinders with constant volume (Nael, 2004).Sampling procedures were conducted carefully in order to obtain soil samples, so that soil structure would not be destroyed. This is because any change in the pore structure may affect soil bulk density. After correct sampling, cylinders containing the sample were transferred to laboratory for drying and weighing. Soil bulk density was calculated for each user based on following equation:

$$\rho_b = \frac{W_s}{V} = \frac{W_s}{V_s + V_a + V_w}$$

In this equation,

ρ_b= soil bulk density based on grams per cubic centimeter

W_s= weight of dry soil per gram

V_s= volume occupied by the solid soil particles per cubic centimeter

V_a= volume occupied by air in the soil per cubic centimeter

V_w= volume occupied by water particles in the soil per cubic centimeter

V = total volume of the soil per cubic centimeter

Determining porosity of soil samples

Soil porosity is calculated by dividing volume of soil pores to total volume of the soil. Several methods are used to calculate soil porosity. In this study, porosity of soil samples was measured using the bulk density while standard bulk density of soil solids was calculated using the equation of [(true density and bulk density)-1] (Omar et al., 2005). True density in most soils is averagely 65.2 grams per cubic centimeter. Changes in true density of most soils are negligible except in such cases as high organic matter in the soil or certain types of minerals.

Measurement of soil organic matter

Many methods are used to determine soil organic carbon in which Walkley-Blak method is considered as the best one. In this method, potassium dichromate in the organic carbon oxidizes in vicinity of sulfuric acid. The remaining dichromate is titrated in presence of iron sulfate reagent. Then, percentage of organic matter is calculated. Walkley-Blak Method is considered as a wet combustion method for estimating organic carbon. To convert organic carbon to organic matter, 724.1 ratio was used. Then, organic matter content of soil was 58%. In this study, the amount of soil organic matter was measured by Wet Oxidation Walkley-Blak Method (Nelson and Sommers, 1982).

Test Method

One gram of air-dried soil was passed through 5.0 mm sieve and poured into 250-mL Erlenmeyer flask. Then, 10 ml of one-normal potassium dichromate was added to the normal sample. The mixture was shaken. Then, 20 ml of concentrated sulfuric acid was added to the Erlenmeyer flask and shaken for a minute. If the sample color was bluish green, dichromate is consumed completely. Then, additional dichromate should be added and allowed to remain in the Erlenmeyer flask for half an hour. Then, 100 ml of distilled water and 5 to 10 drops of Orthophenanthroline were added to the Erlenmeyer flask. Then, the mixture was titrated with 0.5 normal ferrous sulfate. The color changed from orange to light green and finally dark red, which represented the end-point of the titration.

7. A control sample was also prepared.

Calculations $\%O.C = \frac{(V1-V2)N\times 0.003\times 100\times 1.3}{\text{weight of dried soil in the oven}}$

N: normality of ferrous sulfate
V1: volume of potassium dichromate for the control sample
V2: volume of potassium dichromate for the main sample
%O. M = % O.C x 1.724

Statistical Analysis

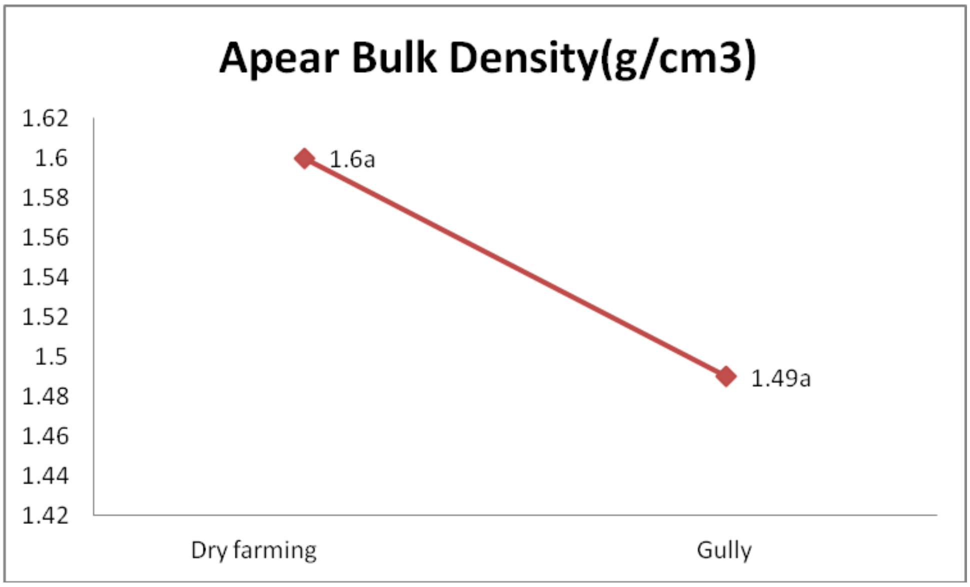
Upon data gathering and recording in the Excel software environment, the SPSS was implemented for statistical analysis and running the independent t-test (5%). Accordingly, the mean iterations were derived for each characteristic corresponding to each landuse and the results were subsequently compared based on the probability level of 5%.

RESULTS AND DISCUSSION

Table 2: Comparison of the Mean Soil Degradation Indices for Different Types of Land Use in the Studied Region

Mean Index			Land Use
Organic carbon (%)	**Porosity (%)**	**Apparent Bulk Density (gr/cm^3)**	
0.23 [a]	0.39 [a]	1.60 [a]*	**Rain-Fed/Dry Farming**
0.097 [b]	0.04 [a]	1.49 [a]	**Ditch Farming**

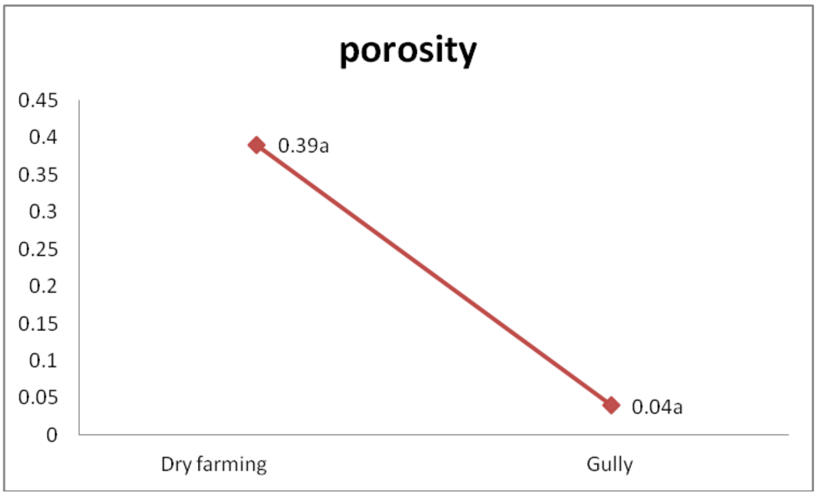
***In each column, the figures designated with a similar letter of alphabet (a or b) did not show a statistically significant difference after t-testing at 5% probability.**



curve. 1: Comparison of Apparent Bulk Density at the Different Land Occupancies Studied (Similar letters of alphabet assigned to figures indicate that no statistically significant difference was observed at a 5% probability level)

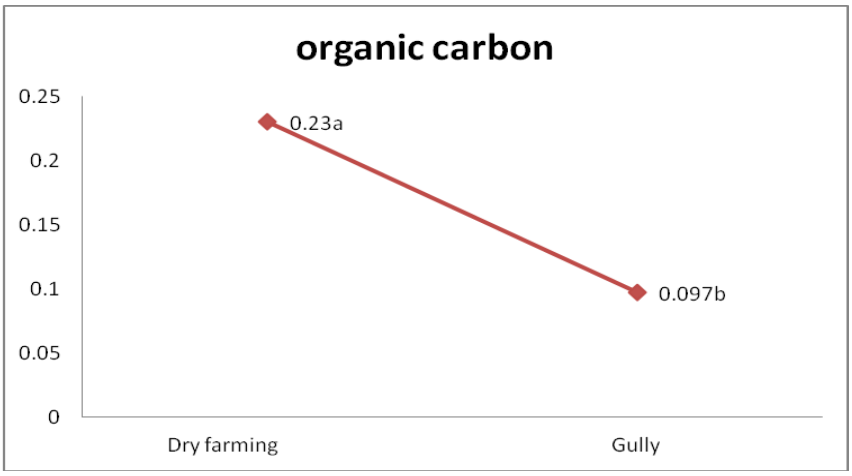
According to curve.1, there is no significant difference statistically between the values of apparent soil bulk density in different land uses. Hajabbassi and colleagues (2007) showed that soil structure disturbance as a result of tillage had decreased the organic content of the soil; leading to an increase in the apparent soil bulk density due to elimination of organic materials as well as fragmentation of soil aggregates resulting from tillage. The smaller particles from crushed soil fill out the pores in the soil, causing an initial decrease in the density of the plow layer. However, the density of this layer would later increase due to impact of raindrops as well as compression of soil with machinery. The 20-year activities for the purpose of turning pasture land into agricultural land have led to a 25% increase in the apparent bulk density of soil. Sloviska (1994) reported that the temporary soil porosity resulting from tillage operations, initially had reduced the Pb content of the clay loam soil to 1.05 gr/cm^3. However, raining increased this density again to 1.24 gr/cm3. Overall, tillage initially led to a reduction in the apparent soil bulk density, but as time passed, this reduced density was counterbalanced and at times soil density even increased to values greater than the initial values. The reason for this is soil fragmentation and consequent filling of larger soil pores with smaller particles/fragments

(Hajabbassi *et al.*, 2002)Ahmadi Ilakhch and colleagues (2002) claimed there was no significant change in the apparent bulk soil density due to land use change, i.e., converting pasture land into agricultural land in the Duraman area in the Charlmahal-o Bakhtiari Province. Their results are confirmed by those obtained in the present research.Tillage type and intensity also affects the apparent density of soil. Some researchers reported an increase in apparent bulk soil density at no tillage as compared with the case when traditional tillage operations were conducted. They attributed the reason for this to the organic materials that exist in soil which neutralize the effects of tillage (Jafari *et al.*, 2009).



Curve. 2: Comparison of soil porosity at different types of land use (The similar letters of alphabet indicate that no statistical differences were found at the 5% level during t-testing).

Curve.2 shows the soil porosity variations resulting from changing land use from pasture to dry farming. Due to the relation that exists between apparent bulk density and porosity of soil, the above reasons are true for this index as well. In a report comparing the effects of cultivation on physical properties of soil, Low (2000) announced that conversion of pastures into agricultural land has reduced soil porosity from 57 to circa 45 percent. He cited the greatest reason for this as destruction/filling of large pores by the debris resulting from soil fragmentation.



Curve. 3: Comparison of Soil Organic Materials in Different
Land Uses (The similar letters of alphabet indicate that no statistical differences were found at the 5% level during t-testing).

According to curve 3, more organic carbon was observed in agricultural land compared with ditch land. the experimental results showed that mean organic carbon content is equal to 0.23% in dry agricultural lands while the former is equal to 0.09% in gullies These results are similar to those obtained by Gholami (2010) who argued that change of land use from pasture to agricultural increased organic materials in soil, whereas in abandoned dry-farmed land, it reduced such materials. Further results showed that organic material increase more in dry farming as compared with irrigated farming. In another study conducted in Javanmardi Pain east of Lordegan, Hajabbassi and Fallahzadeh (2009) obtained similar results and stated that whenever there are low levels of organic material in virgin soil, any action on the soil is equivalent to cultivation. In the course of similar research, Corona and Johnson (1993), and Paoshien (1997) concluded that minimum tillage or cultivation management, or no tillage at all would lead to preservation of organic carbon in soil. Bear (1994) also reported that plant residues on surface soil are dramatically affected by the type of tillage implemented, and that no-tillage methods would increase the amount of these materials in soil.

CONCLUSION AND RECOMMENDATION

Due to cultivation of agricultural land in the studied region, the soil organic carbon content has increased. No significant difference was observed between the apparent soil density in dry farmed and ditch farmed land. The reason is attributed to the long duration of land cultivation. Overall, tillage would initially reduce apparent soil density, but restores it to its previous level as time goes by, at times even increasing it to values greater than the original ones. The reason for this is soil fragmentation as a result of which tiny soil particles fill out large pores (Ferreras *et al.*, 2000). No significant difference was obtained for soil porosity either. The same reasons mentioned for density also hold for porosity due to the relation that exists between soil porosity and soil density. Due to the particular soil and environmental, as well as ethnical conditions in the studied region, and in spite of the fact that ditches are highly abundant in the area, and have even turned into badland in certain places, no critical conditions were observed for certain soil degradation indexes, so that no hindrance was deemed to be necessary in the present study regarding cultivation through dry farming and tillage for obtaining minimum amounts of wheat and oat. Payande (2005) compared the means of soil bulk density in Shaver agricultural research stations in Khuzestan Province. They showed that soil bulk density in surface soil was less than the lower depths. The means were significantly different. Bulk density decreased by increasing years of cultivation from 10 to 20 years. This was due to long-term return of organic c to the soil and decreased soil bulk density. It should also be considered that soil bulk density increases with depth, which is due to loss of organic matter in lower depths and compaction caused by cultivation. Lighter soil texture in abandoned dry lands proves decreased soil porosity from natural grassland to abandoned dry lands (Gholami, 2010).Talayi (2005) and Rasiah (1995) reported increased soil bulk density due to effect of land use change in their study.

Direct and indirect changes in land use change such as converting rangeland to cropland destroys grassland vegetation, which protects severe soil erosion by water and wind. As a result, soil texture is coarsened, soil organic carbon content and nutrients are decreased and the soil is dried (Su and Zhao, 2003). Repeated inappropriate management of soil and crop in pastureland agriculture worsen soil degradation process, which result in rapid expansion of land desertification (Su and Zhao, 2002).Alavadhi *et al.* (2003) identified effects and consequences of land degradation and desertification in Kuwait in a study. They concluded that inherent weakness of soil as well as lack of native vegetation severely worsens land degradation process. Chen and Zhu (2004) conducted a study in Bashang Region with 42,000 square kilometres area in China. They showed that land use changes followed by severe land desertification occurred due to extensive cultivation in pastures during the past decade. As a result, deserted lands expanded to 2,122 square kilometres from 1978 to 1996.Lowe (2000) compared the effects of culture on physical properties of pasture and arable soils. Converting rangeland to cropland decreased total soil porosity from 57% to 45%. The greatest share of this reduction was due to destruction of large pores. West and Post (2003) showed that 5-90 years land use of soils for crop production in semi-arid lands in South Africa resulted in 10%-37% reduction in concentration of carbon and nitrogen in native pastures while soil degradation can be improved by halting agriculture return to original land coverage.

Sue and Zaho (2003) studied desertification in sandy farm fields in Horkin in China. They concluded that dependence of organic carbon and nitrogen on silt and clay is 3 to 6 times greater than dependence of organic carbon and nitrogen on sand. Berger and Kelting (1999) studied physical characteristics of the soil. They believed that physical condition of the soil is important in assessing quality. Romig. (1996) identified land health based on organic matter content. Yang et al (2005) suggested that carbon is stored in soil as organic matter. However, these reserves affect land use. Crop cultivation operations and mineralization increase organic matter content, which decline soil carbon. This decline is significant during 10 to 15 years of cultivation. Arshad (1999) stated that utilization of agricultural systems is associated with unpleasant consequences. Organic matter decomposition is precipitated by turning over and crushing the soil mass and repeated plowing. Then, physical, chemical and biological of characteristics of the soil are affected, which are considered as key soil quality. Khormali (2009) found out that deforestation and agricultural operations reduce organic matter, cation exchange capacity, aggregate stability, soil microbial respiration rate, which result in severe decline in soil quality. Vagon (2006) reported that pastureland use change to agricultural land reduces soil organic matter, which results in land degradation. Changing forest use to agricultural land use has become a significant concern in the world in terms of environmental degradation and global climate change (Valli et al., 1999).

Shamsi Mahmoud Abadi showed that cultivation led to soil degradation in 2010. Organic carbon, cation exchange capacity and mean weight diameter of aggregate were significantly higher in forest and pasture compared to arable land. The highest value of mean weight diameter of aggregate was 2.36 mm in Wildwood Oak while the least value of cultivated land was 0.62 mm. The results showed the effectiveness of soil quality studies in determining status of agricultural lands and natural resources. Fallahzadeh (2011) showed that reclamation and cultivation of saline land improve soil quality indicators. Soil quality is not optimal in saline soils due to unfavorable soil conditions in order to produce plant biomass. Soil quality indicators of saline lands are very low in agriculture.

Although converting intact lands into agricultural land in wet areas reduces soil organic carbon stocks (john et al; 2005), continuous cultivation in dry climates increases soil organic matter compared to non-agricultural lands due to increased amount of biological production. The inconsistency of effect of intact land conversion to agricultural land on soil organic matter content in arid and humid lands mostly depends on vegetation of agricultural lands. Fallahzadeh et al. showed that these conflicted results are due to climatic condition and vegetation in different environmental conditions. Previous cultivation type and land use affect destruction or improvement of soil quality. In the present study, the experimental results showed that mean organic carbon content is equal to 0.23% in dry agricultural lands while the former is equal to 0.09% in gullies. Dry lands had statistically significantly higher organic carbon compared to gullies. The mean index of bulk density in dry land was calculated as 1.6 while the index was calculated as 1.49 in gullies. Mean porosity index was calculated as 0.39 in dry land while the index was calculated as 0.04 in gullies. No statistical significant difference was observed between soils in agricultural lands and gullies in term of bulk density and porosity. Elevated organic carbon content in land use change from 0.09% in gully-form pastures to 0.23% in wheat and barley dry land farming indicated that indigenous vegetation density is generally low. In addition, organic carbon content significantly elevated during cultivation since plant biomass increased and more organic matter was produced. This is because minimum tillage cultivation was performed in these areas. No significant difference was observed in bulk density and porosity of the cultivated gully-form pasture. There is no obstacle to cultivate wheat and barley as dry land farming in this region.

It is suggested that this study be extended to include soil quality, fertility, as well as degradation in this region, along with controlling physical and chemical properties as well as soil mineralogy in longer term. In this way, soil erosion and degradation can be eliminated through correct management.

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