# Assessment the importance of soil organic matter for achieving sustainable agriculture

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**ABSTRACT**

This research highlights the evaluation of the importance of the soil organic matter (SOM) by studying the physical & chemical properties of soil in Kut city of Iraqi Wasit Governorate. That a soil is largely influenced by the nature of the prevailing environmental factors. The soil classification results showed that a soil texture was clay, and appeared through laboratory analysis of soil physical and chemical properties; PH 7.4 , OM 0.9, Ec 8.2, CEC 39, available nitrogen 6.5 ppm, available phosphorus 10.5 ,available potassium 200 ppm, calcium carbonate CaCo3 31 and soil texture components ; clay 52 % ,silt 27 % , and sand 21 % as in table (1). The average monthly value of the climatic elements in the Meteorological Station of Wasit Governorate, which revealed the average annual temperature. 26.064 ° C, humidity 43% and precipitation 134.5mm as in table (2). The improvement of soil properties after the addition of animal manure in the soil that showed ; PH 7.1, Ec 4.1, total N 1.45%, total P 0.4, total K 1%, total OM carbon 34,2% , C/N ratio 24.1%, OM 59% ,which increased the proportion of SOM 98.4%.The comparison between both tables (4) and (5) revealed that addition of OM in the soil at a rate of 2 ton/donum of cow manure caused lowering of both Bulk density from 1.4 gm / cm3 to 1,2 gm/cm3 and Real density from 2.6 gm/cm3 to 2.5 gm/cm3, but the porosity increased from 47% to 52%. This indicates an improvement in soil properties. Drought coefficient was calculated 6.16, so the area was classified as semi-dry as in table (6). All these changes in soil properties due to the addition of organic fertilizer contribute to increasing the quantity & quality of yield

and maintaining the ecosystem from degradation with eco-friendly products.

Key Worde; Organic matter, Sustainable agriculture , Soil, Assessment, Kut.

## INTRODUCION

Sustainable agriculture has recently become a strategic option to secure the biosphere from degradation and to achieve food security with safe healthy food, due to the soil be losing its chemical, physical and biological values by the reason of conventional farming. The solution can only be done by the organic agriculture to repeat soil characteristics . The amount of organic matter in soil depends on some factors ; the input of organic materials from manures & plant residues, its rate of decomposition, soil texture, and climate. These four factors interacting among them to achieve quantity of the organic matter somewhat in a balanced status by depending on the type of soil and agricultural system in the region. For any farming system, the level of organic matter balance in clay soils will be greater than in sandy soils. When plant residues are returned to soil, many different organic compounds undergo decomposition, it is a biological process involving the physical decomposition and biochemical transformation of the complex organic molecules of dead matter into simpler organic matter and inorganic molecules. The continuous addition of decaying plant residues to soil surface contributes to the biological activity of soil organisms and the carbon cycle activation that is the constant transformation of organic and inorganic compounds for plant residues and soil regeneration by simple decomposed compounds, a naturally occurring biological process whose its speed is determined by three main factors: soil organisms, prevailing environment and the type of organic matter. In the decomposition process where different products are released in soil like : carbon dioxide ($CO_2$), energy, water, plant nutrients, whereas the resynthesizes of organic carbon compounds successive by decomposition of dead material and modified organic matter results in the formation of much of organic matter which converts to simpler materials by humification process which called humus [1,2] Humification can occur naturally in soil or artificially in the

production of compost. Organic matter is humified by a combination of; microbes, saprotrophic fungi, bacteria, and animals such as protozoa, earthworms, nematodes, and arthropods. Plant remains contain organic compounds like ; starches, sugars, proteins, carbohydrates, lignin, waxes, resins, and organic acids. Decay in the soil begins with the decomposition of sugars and starches from carbohydrates, while the remaining lignin and cellulose decompose more slowly. Simple starches, proteins, organic acids, and sugars decompose rapidly, but; fats, crude proteins, waxes, and resins remain relatively unchanged for a longer time. Where lignin, which is quickly transformed by white-rot fungi is one of the major component of humus material. The humus which produced by humification is a mixture of complex bio-chemicals compounds from the origin of plant, fauna, and microbes that has many benefits in the soil. Some organisms like ; earth worm produce humus to be the optimal organic manure. The impact of hummus material is positive form in soil characteristics where it slowly decomposes and leaves the darker color for soil, increases soil aggregation and aggregate stability, increases the CEC, the ability to attract and retain soil nutrients as; N, P with other nutrients and activate soil organisms. Which their including are micro-organisms where utilize soil OM as food. As they break down the organic matter, any excess nutrients (N, P, and S) are released into the soil in forms that plants can use it as a nutrient, this release process is called mineralization. The waste products are produced by micro-organisms are also soil organic matter. The waste products are produced by micro-organisms are also soil organic matter . This waste material is slow decomposable than the original plant and animal material, but it can be used by a large number of organisms as food. By breaking down carbon structures and rebuilding new ones or storing the C into their own biomass, where soil biota plays the most important role in nutrient cycling processes and thus in the ability of a soil to provide the crop with sufficient nutrients to harvest a healthy yield. The organic matter contentin especially like humus increase the capacity to save water and keep C from the atmosphere. Implementing farm management strategies which allow plant residues to remain on the soil surface or in

the root zone have been shown soil quality is improved and resulting in increased soil productivity and increases in organic matter enhance cropping sustainability which resulting from improving ; physical, chemical, and biological of soil traits . Our aims are achievement a harmony situation with the ecosystem to keep more of natural resources in place for the next generation[3]. SOM is the foundation for productive soil. It promotes healthy crops, supplies resources for microbes and other soil organisms, also regulates the supply of water, air, and nutrients to plants. SOM can deliver over 50% of the nitrogen and 25% of the phosphorous for crops needs. There is growing evidence that a mixed quality of residues is effective at enhancing SOM pools through supporting a diverse soil food web. However. Soil organic matter responses occur over a long timeframe, often of a decade or more [4]. Efforts to manage SOM to improve crop productivity and environmental quality need to focus on increasing the concentration of C in all pools. This is the best way to achieve the short-term objectives of providing nutrients through SOM turnover and the long-term objectives of increasing nutrient and water holding capacity. One way to achieve this is by adding a diversity of inputs, including crop residues with varying chemical compositions and C: N ratios as well as compost and manure. Decomposition is accelerated by less tillage, which brings organic materials into contact with organisms and generally improves the environment then enhance biological activity. Zero tillage practices reduce the amount of soil disturbance and leave a surface cover of residues. This protects against the erosive forces of wind & water and conserving soil from erosion [5]. In general, planting small cereals such as rye or barley has similar properties for legume crops which using in the agrarian rotations. A forage crops are supplied high nitrogen from leaves and root tissues, where are relatively slow to decompose, further to its contents to nodal bacteria. Showed that the SOM would increase at the top of the soil and with minimal tillage . However, an important finding from long-term experiments is that reduced tillage is most effective at enhancing SOM if it is combined with crop rotations or cover crops that include high residues of plants [6] . Adding organic materials is crucial to formation the slow aggregation can be achieved through

leaving crop and cover crop residues in place or by applying manure amendments. Crop residues include inputs from roots, which are crucial to enhancing the slow and stable organic matter pools. Legume plants generally have large taproot systems with tissues that are slow to decompose and help build SOM. Applying the crop rotation by using a legume crops or plants pasture is highly effective at improving SOM, where Alfalfa production enhanced of soil Carbon by 60 % in a long-term cropping system [7]. Cover crop seeds can be mixed directly with manure by applying zero tillage as a highly effective means of formation organic matter [8]. Winter plants as a cover crops such as cereals are provided great by amounts of residues reaches 1000 lbs. to 4000 lbs. of biomass per acre and can be planted after harvesting cereals crops such as a corn crop or soybean [9]. Managing a combination of plant residues can maximize yield potential in many crops[10]. The better solution is to adding and mixing some plant residues in soil but apply compost or grow a cover crop to replace the residues for conserving the soil, also the manure and compost additions are effective methods to composition soil organic matter[11].



## MATERIALS AND METHODS

This study is carried out in Kut city within Wasit province of Iraq by applied field techniques for three soil samples normal and fertilized with animal manure were selected from agrarian regions for examination of at a depth 0-30 cm, to identify the comparison among them. The soil samples were collected from the different study area at ensuring adequate representation of each site in determining sample selection, adequate care was taken to accommodate the inherent variability of soil materials since insignificant spatial variability often exists over small areas. The bulking procedure for the soil sample was standardized by ensuring that samples collected were of equal volume. The soil analysis was conducted at the soil science laboratory in the Technical Institute of Kut , to study the physical and chemical soil properties such as : soil texture (sand, silt and clay), soil total carbon (C), total soluble nitrogen (N), soil pH, soil organic matter content (O.M.), available phosphorus (P), CEC, and soil potassium content (Kc). Where is determined the soil

particle size composition(soil texture) by taking a sample of the 2 mm by the hydrometer method according to Gee and Bauder (1986). The soil pH was measured in 1:2 suspension of soil in 0.1 m Kcl using the pH meter. Soil organic carbon was determined by the Walkley and Black (1934) method as modified by Allison (1965), while soil organic matter content was determined by multiplying the value of soil organic carbon by Van Barnmelen factor of 1.724. Exchangeable potassium was measured by atomic absorption spectrophotometer; available phosphorus was determined by using the Bray and Kurtz (1945) No. 1 method as modified by Jackson (1964), while soil nitrogen content was Phil-Eze 179 determined by the macro Kjeldahl's method as described by Bremner (1965). CEC was determined by the Soil microbial load was determined in CFU/gm at the Microbiology summation method of Chapman (1965 ). Electrical conductivity measured by Ec meter device, drought coefficient determination according to Dumbarton equation. The elements of the climate were identified based on the Meteorological station in Wasit Governorate. The samples (1gm ) were shaken for one hour in ten milliliters of sterile saline (0.95% w/v NaCl) at 150 rpm. Then a 10-fold dilution to the samples was carried out with sterile saline.



Notice: one donum = 1/4 hectare = 2500 m2

**Importance of research**

For the purpose of the pursuit of sustainable agricultural development, the ecological system must be maintained from deterioration and depletion. This is not will be done without the applying a new of agricultural strategy is adapted by harmonize status with the biosphere ,where will be done by following the organic farming system ,and does not achieving safety food(eco-friendly products ) without using organic fertilizer in agricultural production. So we maximize the importance of organic matter by:

-For healthy - safe food, a sustainable ecosystem and an effective biosphere, that requires application of sustainable agriculture program by utilizing organic farming methods.

-Nutrient supply where organic matter is a reservoir of nutrients that - can be released to the soil. Each percent of the organic matter in the soil releases 20 to 30 pounds of nitrogen, 4.5 to 6.6 pounds of P2O5, and 2 to 3 pounds of sulfur per year.

-Water-holding capacity, that organic matter behaves somewhat like a sponge, with the ability to absorb and hold up to 90 percent of its weight in water. A great advantage of the water-holding capacity of organic matter is that the matter will release most of the water that it absorbs to plants, in contrast, clay holds great quantities of water

-Soil Structure Aggregation, that organic matter causes the soil to clump and form soil aggregates, which improves soil structure. With better soil structure, permeability (infiltration of water through the soil) improves, in turn improving the soil's ability to take up and hold water.

-Erosion Prevention , where indicate the researches that increasing soil organic matter from 1 to 3 percent can reduce erosion 20 to 33 percent because of increased water infiltration and stable soil aggregate formation caused by organic matter.

VIEW OF PROBLEM

Recently the ecosystem is suffering from more challenges most notably is the pollution due to not rational utilizing of natural resources by all sectors. Including agricultural sector which is consider very consumptive sector uses 40% of the land, consumes 70% of the national natural resources, gasses emissions 25 %. So, require to apply sustainable agriculture to protect the biosphere and achieves food security by green techniques for produce the safe nutrient by organic farming for the aim of stability the ecosystem and its maintaining from deterioration.

## AIM OF STUDY

The purpose of this research is to study the importance of adding the organic matter in soil and their comparison with normal soil for the object of knowledge the variance in the changes of physical, chemical and biological soil properties to revealing the role of OM in improving

the soil productivity and their positive reflects on crops yield and their contributions in maintaining of ecosystem and supply the safe - healthy foods production.

## RESULTS AND DISCUSSION

This study evaluates the importance of soil organic matter for achieving sustainable agriculture in Kut city by identify ; physical ,chemical and biological soil traits , that soil is largely influenced by the nature of the environmental factors as ;climate, rainwater, temperature, salinity, groundwater ,humidity ,soil microbes ,techno-genic impact , vegetation ,grazing ,stripping , water and air erosion ,moisture , soil microorganisms, soil organic matter content and soil cation exchange capacity (CEC). The results revealed that the soil of the region is saline and the vegetation cover is lost due to nutrient cycling declines through weak CEC following a reduction in soil microbial activities that generate humus matter also a binding and aggregation agent in the soil is declined , so the crop yield will be low by the reason of high salinity. OM plays a significant role in aggregating the soil particles by fewer the salinity and makes it more resistant to erosion.
The laboratory analysis of soil in the study region is showed the physical and chemical soil properties in the table (1); PH 7.4, OM 0.9, Ec 8.2 DSM-1, cation exchange capacity 39, available nitrogen 6.5 ppm, available phosphorus 10.5 ,available potassium 200 ppm, calcium carbonate CaCo3 31 and soil texture revealed ; clay 52 % ,silt 27 % ,and sand 21 % . Where evaluated the classification of the soil type as clay soil, poor in organic matter, table (2) is explained the average monthly value of climate elements in Meteorological Station of Wasit Governorate, which revealed Annual average temperature; 26.064° C, humidity 43% and rainfall 134.5mm. through a table (2) by climate elements we able to classify the drought factor where is calculated 6.16 which evaluated semi-dry region after comparing this value with the values of a table(4) depending upon Dumbarton equation as mentioned by [12].The table (3) revealed by its comparing with the table(1) the soil properties was improved after mixing of cows compost with soil in physical and chemical properties ;PH 7.1,Ec 4.1 DSM-1,total N

1.45%,total P 0.4%,total K 1%,total OM carbon 34,2%,C/N ratio 24.1%,OM 59%.That soil OM increased by 98.4 %, this is contributing to increasing the quantity and quality of agricultural yield and maintain the ecosystem from deterioration with eco-friendly products. The level of soil organic matter has a significant impact on the rate of biological activity. Organic matter is the main reservoir from which microorganisms derive their nutrient requirements, so microorganisms are affected by the quality and chemical composition of organic matter. Carbohydrate organic matter promotes the types of compounds involved in its composition, such as the decomposed of cellulose, starch and pectin. Since the organic matter has a clear role in influencing the soil texture, it will inevitably reflect on species and the microorganisms types in the soil. When the soil texture is clay, this leads to the anaerobic conditions and thus of the organic matter decomposition will be decreased. The exist of mud mineral is the cause in adsorption more of OM. while when the soil texture is light that it speeds to be up, those activities which increase the speed of organic matter decomposition where appropriate suitable aerobic conditions for organisms activity. Here revealing the role of SOM in improving all soil traits and increasing yield crops in quantitative and qualitative, further to ecosystem conservation from pollution and deterioration, this is consistent with what mentioned and found by [13]. At compare between the both tables(4,5) we noticed that before the addition of the cows' compost by an amount 2 tons /donum, that the Bulk density(Bd) was 1.4 g / cm3 and the Real density(Rd) 2.6 g / cm 3, and the porosity (P%) 47% . After addition of the cows' compost by amount of 2 tons /donum, the effects showed reducing in the both of Bulk & Real density and increasing in porosity percentage as follows; found the Bulk density was 1.2 g / cm3 and the Real density 2.5 g / cm 3 and porosity percentage 52 %, this both lowing in densities is led to increasing the porosity percentage in the soil this in final causes increasing in exchange a volume of water and air in the soil, the porosity has a great impact on the growth of crop roots . we conclusion that crops productivity is increased by the addition of organic fertilizer in the soil due to the improvement of the physical properties of soil, a study indicated to increasing of the wheat yield by

7-8% when adding the organic fertilizer in the soil, where organic manure is analyses by the microorganisms in the soil and this decomposition is produces some of Plant nutrients such as; carbon, hydrogen, nitrogen, phosphorus and other nutrients which needs by the plant in its growth. conducted the calculation of the porosity percentage by applying the follows Equation: P% = (1-(B.d/R.d) x 100.

and the table (6) indicates to standard values of climate according to Dumbarton classification where through it calculated the drought coefficient was 6.16 which classified semi-arid region.

Table (1) Physical and chemical characters for soil in study region

| Properties | Value |
|---|---|
| PH | 7.4 |
| Organic matter | 0.90% |
| Ec dsm-1 | 8.2 |
| Cation exchange capacity Meq.100g soil(CEC) | 39 |
| Available N ppm | 6.5 |
| Available P ppm | 10.5 |
| Soluble K ppm | 200 |
| Calcium carbonate CaCo3 | 31 |
| Soil texture | Value |
| Clay | %52 |
| Silt | %27 |
| Sand | %21 |
| Texture class | Clay |



Table(2) The monthly average of climate elements in Kut Governorate station

| Month | Temp. **°C** | Humidity **%** | Rainfall mm |
|---|---|---|---|
| Jan. | 11.7 | 75 | 31 |
| Feb. | 14 | 63 | 17.5 |
| Mar. | 18 | 65.64 | 21 |
| Apr. | 25 | 45.35 | 12 |
| May | 32 | 31 | 1 |
| June | 44 | 24 | 0 |
| July | 45 | 25 | 0 |

| | | | |
|---|---|---|---|
| Aug. | 38 | 25 | 0 |
| Sep. | 31 | 26 | 1 |
| Oct. | 31 | 39 | 7 |
| Nov. | 14 | 55 | 20 |
| Dec. | 9 | 68 | 24 |
| Annual average | 26.064 | 43 | 134.5 |

Table(3) Properties of organic matter in study region

| Property | Value |
|---|---|
| PH | 7.1 |
| Ec | 4.1 |
| Total N | %1.45 |
| Total P | % 0.4 |
| Total K | %1 |
| Total org.carbon | %34.2 |
| C / N ratio | %24.1 |
| O M | %59 |



Table (4):Bulk & Real density and porosity percentage in soil before adding the organic matter by two tons/dunum

| **Property** | **Value** |
|---|---|
| **Bulk density** | **1.4 gm/cm$^3$** |
| **Real density** | **2.6 gm/cm$^3$** |
| **Porosity** | **47%** |

Table(5) :Bulk & Real density and porosity percentage in soil after adding the organic matter by two tons/ dunum

| **Property** | **Value** |
|---|---|
| **Bulk density** | **1.2 gm/cm$^3$** |
| **Real density** | **2.5gm/ cm$^3$** |
| **Porosity** | **52%** |

Table(6 ) Indicates to standard values of climate according to Dumbarton classification

| Drought indicator | Dominant climate character | Calculated value |
|---|---|---|
| Less than 5 | Dry | - |
| 5-9.9 | Semi- dry | 6.16 |
| 10- 19.9 | Semi-humid | - |
| 20 -29.9 | Humid | - |
| More than 30 | Very humid | - |

## CONCLUSIONS

We conclude from the study that the soil of the study area is deteriorated due to several factors where have been referred in the research and this is reflected negatively on the soil properties and yield. Therefore, adoption of the sustainable agriculture method is a better option for preserving the soil from degradation, by applying the organic farming system for achieving a soil stability , a high yield in quantity & quality then healthy eco-friendly products with maintaining the ecosystem from deterioration . The role of organic matter in soil can be summarized in the following:

1- Organic matter consider as a store where provides of nutrients for plants & microorganisms and increases the exchange capacity of cations.

2- Organic matter increase the composition and stability of soil complexes.

3- Organic matters reduce both Bulk &Real densities and increase soil porosity percentage so reduce the superficial erosion of the soil.

4- Organic matter where increases to absorb heat from the surrounding because of its dark color, which contributes to the acceleration of seed germination and plant growth.

5- Organic matter is an important source of carbon and energy to supply it to microorganisms in the soil.

6- Organic matter make less coherent in the soil , which helps the growing roots and penetration in soil.

## RECOMMENDATIONS

Sustainable ecological agriculture cannot be achieved without organic agriculture, which guarantees; environmental safety, product quality and the health of organisms, so we recommend the following:
-Require the activation of relation among producer(plant), consumer(human, animal) and decomposer (microorganisms) by harmony situation to protect the life cycle of organisms and ecosystem by sustainable agriculture.

- Must the dealing with the soil by healthy form without any damage by organic agriculture.

-Food security not achieving without sustainable agriculture
-Healthy and safe foods production not achieved without the application of sustainable agricultural development.

-Must prevent chemical control for pests & weeds and limiting of-chemical fertilizers utilization to produce healthy products by organic manure.

- Follow a rational consumption of natural resources is necessary for their renewability and sustainability for achievement the natural balance by sustainable agrarian.

## REFERENCES

1-Juma, N.G. 1998. The pedo-sphere and its dynamics: a systems approach to soil science, Volume 1, Edmonton, Canada, Quality Color Press Inc. 315 pp.

2-Brussaard, L. 1994. Interrelationships between biological activities, soil properties and soil management. In D.J. Greenland & I. Szabolcs, eds. Soil resilience and sustainable land use, pp. 309–329. Wallingford, UK, CAB International.

3-Arkansas Fayetteville, 2013, ARDF Bulletin 5 Neal Mays, Discovery LINKS connecting science to the farm, On-Farm Benefits of Soil Organic Matter, Arkansas Discovery Farms Program Department of Crop & Soil, Environmental Sciences, report, pp.1-3, 115 Plant Sciences Bldg. The University of AR.

4-Sieglinde S. Snapp, 2011, Kellogg, Biological Station and Department of Crop and Soil Sciences, Advanced Soil Organic Matter Management, Extension Bulletin, E-3137, pp.1-5 Michigan State University.

5-Doll, J. E., & Snapp, S. S. , 2009, Sustainable Crop Removal: Maintaining Soil Quality (E3079) East Lansing: Michigan State University, MSU Extension. Retrieved from HTTP. Bulletin,pp,1-2 web2.msue.msu.edu/bulletins/Bulletin/PDF/E3079.pdf.

6-Franzluebbers, A. J. (2010). Achieving soil organic carbon sequestration with conservation agricultural systems in the southeastern United States. Soil Science Society of America Journal.74(2):347–357. Retrieved publications/sssaj/articles/74/2/347/ .from www.soils.org.

7-Grandy, A. S., & Robertson, G. P. (2007). Land-use intensity effects on soil organic carbon accumulation rates and mechanisms. Ecosystems. 10, 58–73. Retrieved from www.msu.edu/~grandya1/Grandy_Ecosystems.pdf.

8-Harrigan, T. M., Mutch, D. R., & Snapp, S. S. (2006, Manure slurry - enriched micro-site seeding of bio suppressive covers. Applied Engineering in Agriculture, 22(6):827–834. Retrievedfromwww.extension.org/mediawiki/files/a/ad/Slurry seeding of bio suppressive cover crops.pdf.

9-Rector, N., Harrigan, T. M., Mutch, D. R., & Snapp S. S. (2009, -9 February). Cereal Rye: Manure and livestock's new best friend. In: Manure Sense, Feb. 2009, pp. 21–24. Retrieved from/www.animalagteam.msu.edu/Portals/0/manure_sense.pdf.

10-Snapp, S. S., Nyiraneza, J., Otto, M., & Kirk, W. (2003, Managing Manure in Potato and Vegetable Systems (E2893). East Lansing:

Michigan State University, MSU Extension. Retrievedfromhttp://web2.msue.msu.edu/bulletins/Bulletin/PDF/E2893.

11-Thelen, K. D., Fronning, B. E., Kravchenko, S. A., Min D.-H., & Robertson, G. P. (2010). Integrating livestock manure with a corn-soybean bioenergy cropping system improves short-term carbon sequestration rates and net global warming potential. Biomass and Bioenergy, 34(960–966) DOI:10.1016/j.biombioe.2010.02.004.

12-Ibraheem.M.Aliyas, Ali Kh.Alazzam and Salem.Hassen, 2016, ASSESSMENT THE BIODIVERSITY IN THE NATURE RESERVE OF SINJAR MOUNTAIN, International Journal of Current Research, 8, (11), 40874–40878, Northern Technical University, Technical Institute of Mosul / Iraq

13-A.E. Johnston, P.R Poulton, and K. Coleman. ,2009, The Essential Role of Soil Organic Matter in Crop Production and the Efficient use of Nitrogen and Phosphorus, Advances in Agronomy 101:1-57. UK. AL5 2JQ. ac.uk, E-mail: johnny.johnston@rothamsted.