The Pharma Innovation Journal 2021; 10(10): 706-710

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; 10(10): 706-710

www.thepharmajournal.com
Received: 08-08-2021
Accepted: 25-09-2021

Ganesh Narayan Yadav
Ph.D., Scholar, SKN Agriculture University, Jobner, Jaipur, Rajasthan, India

Rakesh Sammauria
Professor, SKN Agriculture University, Jobner, Jaipur, Rajasthan, India

Seema Sharma
Associate Professor, SKN Agriculture University, Jobner, Jaipur, Rajasthan, India

SL Yadav
Assistant Professor, Agriculture University, Kota, Rajasthan, India

ARK Pathan
Professor, SKN Agriculture University, Jobner, Jaipur, Rajasthan, India

Jhabar Singh
Associate Professor, SKN Agriculture University, Jobner, Jaipur, Rajasthan, India

PS Shekhawat
Associate Professor, SKN Agriculture University, Jobner, Jaipur, Rajasthan, India

Corresponding Author:
Ganesh Narayan Yadav
Ph.D., Scholar, SKN Agriculture University, Jobner, Jaipur, Rajasthan, India

Crop and soil management improves carbon sequestration

Ganesh Narayan Yadav, Rakesh Sammauria, Seema Sharma, SL Yadav, ARK Pathan, Jhabar Singh and PS Shekhawat

Abstract
In recent years, there has been a loss of soil carbon due to improper soil and crop management practices. Worldwide, about 1417 grams of soil carbon are stored in the first meter of soil, and about 456 grams are contained in dead organic matter and vegetation.
The ability of soils to sequester CO_2 is increased when they contain a high amount of organic matter. As an example of improper agronomic practices contributing to soil carbon loss in the form of CO_2, improper tillage operations, crop rotations, residue management, fertilization, and similarly little or no use of organic fertilizers have all been responsible. About 25 to 30% of global GHG emissions from agriculture come from CO_2, N_2O, and CH_4. Studies have shown that a combination of proper tillage operations, crop rotations leading to an improvement in soil organic matter, as well as organic amendments like FYM, compost and vermin-compost can significantly improve soil organic matter.

Keywords: Soil carbon, agronomic practices, tillage, crop rotation, crop residues

1. Introduction
Sequestration of soil carbon (C) involves removing atmospheric CO_2 from the air via plants and storing it in the soil organic matter (Lal R., 2004) [18]. Plant biomass, soil organic matter, and carbon dioxide (CO_2) are mainly carbon-based products. Soil organic carbon (SOC), which is a major component of SOM, is separated into stable and labile fractions (Huangs and Zhang). As part of the humification process, soil organic matter plays a very important role in the formation of stable humus fractions as well as in fertilization management (Yang and Wand, 2016) [40]. In the first meter of soil depth, 1417 Pg of soil carbon is stored; 456 Pg is stored in vegetation and dead organic matter above and below ground. Around 1500 Pg of C can be found in Earth's soils, a number that is two to three times greater than what is found in Earth's vegetation (Peng, *et al*, 1990 and Evwaran *et al*, 1993) [28, 7]. The atmospheric carbon pool contains ~800 Pg of CO_2-C and is increasing at the rate of 4.2 Pg C per year, 0.54 percent per year. The amount of carbon in the atmosphere has increased by 30% in the last 150 years. CO2 concentrations in the atmosphere have increased from 280 parts per million in the pre-industrial era to 390 parts per million in 2010 (a 39 percent enrichment) and other greenhouse gases (GHGs) have impacted the Earth's mean temperature and precipitation (IPPC, 2007) [12]. Nowadays, intensive agriculture usually results in significant soil degradation and carbon depletion, because intensive soil utilisation is not only necessary but also imperative in today's agriculture and human food chain, so it should be followed and coupled with appropriate conservation practices (Bonilla *et al*., 2015 and Lal R. 2006) [27, 16]. As much as 30% of the world's greenhouse gases are emitted by the agriculture sector, primarily due to inappropriate soil and crop management practices. In agricultural soils, carbon sequestration means the increase of soil carbon storage. Main agronomic and related practices that can be helpful in SOC sequestration include:

- Minimum tillage or adopt of no-tillage (NT);
- Adoption of soil health improve and eco-friendly farming systems;
- Incorporation of cover crops;
- use of mulch either in the form of crop residues or synthetic materials;
- Minimization of soil and water losses by surface runoff and erosion;
- Adoption of integrated nutrient management practices for the improve of soil fertility;
- Applications of organic amendments; and
- Promotion of farm forestry.

1.1 Benefits of soil carbon sequestration include the following

- It can be helpful in the reduction of CO2 emissions.
- It can reduce the emissions of different GHGs.
- It can be helpful in the decreases of atmospheric temperatures.
- It helps in maintaining suitable biotic habitat.
- It reductions nutrients losses.
- It can improve soil health and productivity.
- It can increase water conservation.
- It can promote and sustain root growth.
- It can decrease soil erosion.

Agriculture sector can be supportive in the lessening of emissions of GHGs, and if suitable agronomic practices are to be adopted, then agricultural soils have the potential to act as a sink for CO_2 sequestration. Healthy soils can be supportive in combating the climate change because soils having high organic matter can have higher CO_2 sequestration potential.

2. Agronomic practices

Various agronomic and related practices that can be helpful in CO_2 sequestration are given below.

2.1 Tillage

The main objective of tillage is the physical manipulation of upper soil layers for the making of soil bed, incorporation of fertilizers, crop residues, and same as to control weeds. Tillage methods differ around the world depending on the soil, climate, crop management, and technological availability. The ability of agricultural soils to sequester carbon is dependent on the interaction between tillage, soil structure, and soil organic matter dynamics. Tillage has a complex and variable impact on soil carbon dynamics (Sombrero *et al*., 2010) [34]. Soil carbon levels have dropped from 30 to 50 percent globally to as low as 20 percent as a result of traditional tillage methods (Schlesinger, 1985 and Sharma *et al*., 2000) [19, 33]. Plowing is the primary source of SOC oxidation and CO2 emissions to the atmosphere, and when NT, CP, and MP are in a non-steady state; all three types of tillage systems are at risk of failing to sequester large amounts of soil organic carbon (Kaisi *et al*, 2015 and Olson, 2010) [25]. The more losses of carbon typically follow initial cultivation (Davidson *et al*., 1993 and Haas *et al*., 1957) [5, 9]. Moldboard ploughs are extensively employed in the world, followed by secondary tillage operations, which is essentially intensive tillage. However, over the years, intensive tillage has been replaced with less intensive tillage, in which soil is disturbed to the bare minimum. No tillage improves the stability and number of soil aggregates, whereas conventional tillage degrades soil structure and accelerates soil organic matter decomposition. Compared to conventional tillage, conservation tillage techniques preserve more crop residues on the soil surface and have a higher SOC concentration in the surface layer (Drury *et al* 1999 and Huchinson *et al*. 2007) [6, 11]. Tillage and cropping systems can influence microbial activity, which finally affects soil organic carbon dynamics and stability (Scow, 1997 *et al*., 1997 and Paustian *et al*., 1997) [32, 26], and soil mineralization; it can be decreased by reducing or eliminating soil tillage and increasing cropping intensity and plant production efficiency. In case of no-tillage as litter accumulates at the soil upper surface, which decrease evaporation from the soil because surface residues and same as standing stubbles decrease wind speed at the soil surface, which finally results in less turbulent exchange of water and heat. Reduction in soil temperature through the application of surface mulches and no-till practices is important for maintaining stocks of soil organic matter especially in tropical areas soils (Lal, 1989) [15]. All this presents that the adoption of conservation tillage practices can be supportive in the reductions of emissions of CO_2 into the atmosphere and similarly can be helpful in the carbon sequestration in the soil.

2.2 Nutrient management

Chemical fertilizers, particularly N_2O, are a source of GHG emissions. Furthermore, fertilizer manufacturing and transportation are linked to GHG emissions. The use of fertilizers wisely boosts agricultural yields and profitability, and cultivated soils have contributed around 50 Pg CO_2 to the atmosphere through the mineralization of soil organic carbon (Lal, 2011) [17]. Fertilizers have enhanced agricultural output substantially, yet studies show that a long-term nitrogen fertilizer reduces soil microbial activity (Marschner *et al*., 2003, Bowden *et al*., 2004, Ramirez *et al*, 2012, and Fey *et al*., 2014) [24, 3, 30, 8]. Continuous application of balanced fertilizers is required for long-term soil fertility and crop productivity (Verma, 2012) [37]. Crop wastes and nutrients, particularly nitrogen, contribute up to 21.3–32.5 percent of carbon sequestration (Windeatt, *et al*., 2014) [39]. The long-term impacts of ongoing nitrogen fertilizer on soils, on the other hand, are intricate and unknown. It may be inferred that the proper use of fertilizers based on soil conditions can aid in maximum carbon sequestration, maximum crop yield, and reductions in various GHG emissions.

2.3 Animal manure and compost application

Animal manure is animal's excreta which is collected from livestock farms and barnyards and is used to enrich the soil, while compost is the material which largely consists of decayed organic matter and is applications for fertilizing and conditioning of agricultural soil. Manure application is crucial for soil health and is a source of carbon, and its application to various agricultural fields has an effect on carbon content. The used to green manuring, when compared to the application of only NPK, enhanced carbon sequestration in a rice-wheat cropping system, while green manuring (Kukal, *et al*., 2009) [14]. Composting not only boosts net primary production, but it also improves the soil's C content. It has been found that reducing the use of manures and organic fertilizers has an impact on soil microbes and nutrient regimes in addition to stable organic compounds. The favourable effect of combining mineral fertilizers with organic manures was supported by Liu *et al*., 2013 [21]. This all represents that the application of animal manure, compost, etc. along with other inorganic fertilizers is beneficial for both soil health and environment.

2.4 Crop rotations

Crop rotations refer to the succession of crops cultivated on the same piece of land in a predictable pattern. The following crops could last two or more years. Crop rotations, climates, soils, and crop-related management methods all have an impact on carbon sequestration. Soil organic matter is depleted in intensive cropping systems, but balanced fertilization with NPK, application of organic amendments, and similarly application of crop residues can increase carbon sequestration levels to 5–10 Mg ha per year because these amendments contain 10.7–18 percent carbon, which can also

help with carbon sequestration (Manadal *et al*. 2005) [23].
Various legume crops, such as peas, lentils, alfalfa, chickpea, sesbania, etc., can serve as substitute sources for nitrogen. Applications of crop rotations especially by using legume cover crops, which contain carbon compounds that are likely more resistant to microbial metabolism, can make soil carbon more stable. Syswerda *et al*. (2011) [36] reported the results of a long-term study (over a 12-year period) of an organic management system that involved various crop rotations. According to them despite of extensive tillage for weed control, increase in soil carbon sequestration was recorded (Wickings, *et al*., 2012) [38]. This presents that, while keeping economic considerations in mind, selecting appropriate crop rotations based on soil and environmental conditions can aid in carbon sequestration, which not only improves soil fertility but also reduces CO_2 emissions into the atmosphere while increasing farmer income.

2.5 Residues management
Crop residues are the vegetative remains of crop plants that are left to perish in agricultural fields after the crop has been harvested. Crop residues play a critical role in soil organic matter management and soil quality enhancement (Chen Zhang-du, *et al*., 2015) [4]. Mulching enhances soil moisture, minimizes soil erosion, and reduces carbon loss from the soil and crop leftovers, which are absorbed into the soil to increase organic matter. As a result of increased carbon inputs and reduced soil disturbance, a direct seedling mulch-based farming strategy enhances soil organic matter (Paustian, 1997) [26]. In the top 0–5 cm of soil, mulch can improve soil organic matter and carbon sequestration. It enhances the physical and chemical features of soils and can boost carbon sequestration by up to 8–16 Mg ha1 per year in agricultural soils. Mulch-based farming techniques improve soil organic matter accumulation, owing to higher carbon inputs and less soil disturbance (Paustian, 1997) [26]. Direct seedling straw mulch has the ability to alleviate heat stress by increasing infiltration, reducing evaporation, and increasing soil organic carbon and nitrogen efficiency (Lal, 1985 and Hobbs, 2000) [19, 10]. Increasing the amount of residues added to soils increases net primary productivity. All of this presents that mulching and using agricultural leftovers can boost soil microbial activity, reduce heat stress, aid in water storage, and improve soil organic carbon.

2.6 Cover crops
The purpose of a cover crop is to help the soil rather than to increase crop yield. Cover crops increase soil organic carbon through biomass, improve soil aggregates and stability, and protect the soil from surface runoff, all of which improve soil quality. Green manuring, on the other hand, increases the biomass returned to the soil, resulting in a larger soil carbon sink. Cover crops have been shown in studies to be an effective way to combat climate change.
The use of cover crops in intensive row crop rotations with various tillage treatments has been found to absorb soil organic carbon, according to Olson *et al*, 2010 [25]. Olson *et al*. published the findings of a study that included no-till (NT), Chisel plough (CP), and Moldboard plough (MP) tillages with and without cover crops. With or without cover crops, annual corn and soybean yields were statistically equal. For the same soil depth layer and tillage treatments, the average annual corn and soybean yields were statistically the same for NT, CP, and MP systems with or without cover crops. NT, CP, and MP tillage treatments, on the other hand, sequestered SOC with cover crops. With cropping systems in mind, proper selection and planting of cover crops can improve soil organic carbon levels.

2.7 Use of improved crop varieties
Soil organic carbon can be improved by selecting improved cultivars of various crops that can improve both above and below ground biomass. According to Machado *et al*. (2006) [22], crop species with large root systems have the ability to enhance soil organic carbon in NT soils. According to Kell (2011) [13], soil carbon storage can match anthropogenic emissions for the next 40 years through boosting root growth in agricultural crops. All of this suggests that using superior crop types with deeper root systems and higher yields can boost both yields and soil fertility.

2.8 Soil biota management
Because bacteria improve the soil's physical, chemical, and biological qualities, soil microbial activities can aid in biological carbon sequestration. The soil biota is the living part of soils and comprises of a great number and variety of micro- and macro organisms. They interact with one another and with plants, providing direct nourishment and other advantages. Their physical structure and products contribute significantly to the soil structure. They're also in charge of breakdown of organic materials and the transformation of organically bound nitrogen and minerals into plant-available minerals. These organisms govern their own populations as well as the populations of entering microbes using biological control systems. Micro- and macro-organisms are critical to maintaining ecosystem function, and crop management approaches have a considerable impact on their numbers. Bacteria, fungus, protozoa, and certain nematodes are examples of microorganisms. Invertebrates such as micro- and macro-arthropods, termites, and earthworms are also included.
Microorganisms make up nearly a quarter of all biomass on the planet, according to some estimates. The management of soils in agricultural and forest habitats has an impact on these creatures. Soils also range in their ability to support different micro- and macro-organisms' survival and growth. Carbon sequestration was higher up to 49.9 g C kg1 in soils rich in soil microorganisms such as soil bacteria and fungus, according to research (Bailey *et al*., 2002) [2]. As a result, the employment of various microorganisms that are favourable to both the soil and the environment will increase soil carbon sequestration and crop yields.

2.9 Bio char
Bio char is carbonised biomass that is derived from renewable resources and stored in soils. It can also be synthesised using pyrolysis. Because it promotes crop productivity and maintains the soil's cation exchange ability, water holding capacity, and nutrient retention capacity, Bio char can also benefit soil health through carbon sequestration. It is stable for thousands of years, reducing the release of terrestrial carbon dioxide into the atmosphere (Lehmann, 2007) [20]. Bio char has been shown to promote carbon sequestration in soil due to its long residence duration. Another study found that using Bio char lowers the co-localization of polysaccharides-carbon and aromatic carbon by lowering carbon metabolism in Bio char-activated soil due to carbon stabilization. Soil management using various types of organic amendments and

their incorporation by earthworms has also been shown to support microaggregate formation, C, and N retention in agricultural soils (Pulleman, *et al*., 2005) [29].

2.10 Agro-forestry
Agro-forestry is a hybrid of agriculture and forestry in which agricultural crops are planted alongside perennial trees and bushes. Different types of trees, such as orchards, fruit trees, and forests, can be planted on croplands to promote soil carbon sequestration. Agro-forestry also aids in the efficient use of water and, as a result, increases the farmer's income. As a result, promoting agro-forestry while taking into account soil conditions, climate, and crop production is beneficial to the soil, environment, and farmers.

3. Conclusion
CO_2 levels are rising at a rate of 2.3 parts per million per year, resulting in increased global heat and pollution. The agricultural industry is responsible for up to 30% of GHG emissions. Agriculture that is both sustainable and profitable is critical to humanity's survival. The use of various agronomic management strategies can aid in carbon sequestration. No-tillage or reduced-tillage, nutrient management, cover crops, crop rotations, green manuring, animal manure application, agro-forestry, and other approaches are examples. Adoption of these various agronomic approaches will boost crop yields while also increasing farmer revenue.

4. Reference

1. Al-Kaisi MM, Yin X. Tillage and crop residue effects on soil carbon and carbon dioxide emission in corn-soybean rotations. Journal of Environmental Quality 2005a;34:437-445. DOI: 10.2134/jeq2005.0437.
2. Bailey VL, Smith JL, Bolton H. Fungal -to- bacterial ratios in soils investigated for enhanced C sequestration. Soil Biology and Biochemistry 2002;34:997-1007.
3. Bowden RD, Davidson E, Savage K, Arabia C, Steudler P. Chronic nitrogen additions reduce total soil respiration and microbial respiration on temperate forest soils at the Harvard Forest. Forest Ecology and Management 2004;196(1):43-56.
4. Chen Zhang-du, Zhang Hai-lin, Dikgwatlhe S-Batsile, Xue Jian-fu, Qiu Kang-Chang, Tang H ai-ming, *et al*. Soil carbon storage and stratification under different tillage/residue – Management practices in double rice cropping system. Journal of Integrative Agriculture 2015, 1-16. Advance on line publication. DOI: 10.1016/ s2095-3119(15)61068-1
5. Davidson EA, Ackerman IL. Changes in soil carbon inventories following cultivation of previous untilled soils. Biogeochemistry 1993;20:161-164.
6. Drury CF, Tan CS, Welacky TW, Oloya TO, Hamil AS, Weaver SE. Red clover and tillage influence on soil temperature, water content, and corn emergence. Agronomy Journal 1999;19:101-108.
7. Eswaran H, Van Den Berg E, Reich PF. Organic carbon in the soils of the world. Soil Science Society of America Journal 1993;57:192-194.
8. Frey SD, Ollinger S, Nadelhoffer K, Bowden R, Brzostek E, Burton A, *et al*. Chronic nitrogen addition suppress decomposition and sequester soil carbon in temperate forests. Biogeochemistry 2014;121(2):305-316.
9. Haas HJ, Evans CE, Miles EF. Nitrogen and carbon changes in Great Plains soils as influenced by cropping and soil treatments. Technical Bulletin No.1164 USDA, State Agricultural Experiment Stations 1957.
10. Hobbs PR, Gupta RK. Sustainable resource management intensively cultivated irrigated rice-wheat cropping systems of the Indo-Gangetic Plains of South Asia. Strategies and options. In: Singh AK, editor. Proceedings of the International Conference on Managing Resources For Sustainable Agricultural Production. In the 21st century. New Delhi, India 14-18 February 2000. Delhi, India: Indian Society of Soil Science 2000, 157.
11. Huchinson JJ, Campbell CA, Desjardins RL. Some perspectives on carbon sequesteration in agriculture. Agricultural Meteorology 2007;142:288-307.
12. IPCC. Climate Change 2007. The Fourth Assessment Report. The Physical Science Basis. Cambridge, United Kingdom: Cambridge University Press 2007.
13. Kell DB. Breeding crop plants with deep roots: Their role in sustainable carbon, nutrient and water sequestration. Annals of Botany 2011;108(93):407-418.
14. Kukal SS, Rasool R, Benbi DK. Soil organic C sequestration in relation to organic and inorganic fertilization in rice-wheat and maize-wheat systems. Soil and Tillage Research 2009;102:87-92.
15. Lal R. Conservation tillage for sustainable agriculture: Tropic Vs. temperate environments. Advances in Agronomy 1989;42:84-191.
16. Lal R. Enhancing crop yields in the developing counteries through restoration of soil organic carbon pool in agricultural lands. Land Degradation and Development 2006;2(17):197-209. DOI: 10.1002/Idr-696
17. Lal R. Sequestering carbon in soils of agro-ecosystems. Food Policy 2011;36:S33-S39.
18. Lal R. Soil carbon sequestration to mitigate climate change. Geoderma 2004;123:1-22.
19. Lal R. Tillage in lowland rice-based cropping systems. In: Soil Physics and Rice. Philippines: IRRI 1985, 283-307.
20. Lehmann J. Bio-energy in the black. Frontiers in Ecology and the Environment 2007;5:381-387.
21. Liu E, Yan C, Mei X, Zhang Y, Fan T. Long-term effect of manure and fertilizer on soil organic carbon pools in dryland farming in Northwest China. PloS One 2013;8(2):e56536. DOI: 10.1371/Journal pone.0056536
22. Machado S, Rhinhart K, Petrie S. Longterm cropping systems effects on carbon sequestration in eastern Oregon. Journal of Environmental Quality 2006;35:1548-1553.
23. Manadal B, *et al*. The potential of cropping systems and soil amendments for carbon sequestration in soils under long-term experiments in subtropical India. Global Change Biology 13:357-369.
24. Marschner P, Kandeler E, Maschner B. Structure and function of the soil microbial community in a long - term fertilization experiment. Soil Biology and Biochemistry 2003;35(3):453-461.
25. Olson KR. Impacts of tillage, slope and erosion on soil organic carbon retention. Soil Science 2010;175:562-567. DOI: 10.1097/SS.09o13e3181foc 2837.
26. Paustian K, Collins HP, Paul EA. Management controls on soil carbon. In: Paul EA, Paustin K, Elliott ET, Cole CV, editors. Soil Organic Matter in Temperate Agroecosystems. Boca Raton, and FL: CRC Press 1997, 15-49.

27. Plaza- Bonilla D, José Luis A, Cantero-Martinez C, Fanlo R, Iglesias A, Alvaro-Fuentes J. Carbon management in dryland agricultural systems. A review. Agronomy for Sustainable Development 2015;35(4):1319-1334. DOI: 10.10007/s 13593-015-0326-x
28. Post WM, Peng TH, Emanuel WR, King AW, Dale VH, De Angelis DL. The global carbon cycles. American Scientist 1990;78:310-326.
29. Pulleman MM, Six J, Uyl A, Marinissen JCY, Jongmans AG. Earthworms and management affect organic matter incorporation and microaggregates formation in agricultural soils. Applied Soil Ecology 2005;29:1-15.
30. Ramirez KS, Craine JM, Fierer N. Consistent effects of nitrogen amendments on soil microbial communities and processes across biomes. Global Change Biology 2012;18(6):1918-1927.
31. Schlesinger WH. Changes in soil carbon storage and associated properties with disturbance and recovery. In: Trabalha JR, Reichle DE, editors. The changing carboncycle: A global analysis. New York: Springer-Verlag 1985, 194-220.
32. Scow KM. Soil microbial communities and carbon flow in agro ecosystems. In: Jackson LT, editor. Ecology in agriculture. San Diego, CA: Academic press 1997, 367-413.
33. Sharma PK, Bhushan L, Ladha JK, Naresh RK, Gupta RK, Balasubramanian V, *et al*. Crop - water relations in rice-wheat systems and water management practices in a marginally sodic, medium textured soil. In: Bouman *et al*., editors. Water-wise rice production. LOS Banos (Philippines): International Rice Research Institute 2000, 223-235.
34. Sombrero A, de Benito A. Carbon accumulation in soil. Ten-year study of conservation tillage and crop rotation in semi-arid area of castle- Leonion Spain. Soil and Tillage Research. 2010;107:64-70
35. Sun Y, Huangs YUX, Zhang W. Stability and saturation of soil organic carbon in rice fields: Evidence from a long-term fertilization experiment in subtropical China. Journal of Soils and Sediments 2013;13(8):1307-1334. DOI: 10.1007/s 11368-013-0741
36. Syswerda SP, Corbin AT, Mokma DL, Kravchenko AN, Roberson GP. Agricultural management and soil carbon storage in surfaces vs deep layers. Soil Science Society of America Journal 2011;75(1):92.
37. Verma G, Sharma RP, Sharma SP, *et al*. Changes in soil fertility of maize – wheat system due to long-term use of chemical fertilizers and amendments in an alfisol. Plant, Soil and Environment 2012;58:529-533.
38. Wickings K, Grandy AS, Read SC, Cleveland CC. The origin of litter chemical complexity during decomposition (Njohnson Ed.). Ecology Letters 2012;15(10):1180-1188.
39. Windeatt JH, Ross AB, Williams PT, Forster PM, Nahil MA, Singh S. Characteristics of Bs from crop residues: Potential for C sequestration and soil amendment. Journal of Environmental Management 2014;146:189-197.
40. Yang R, Yz S, Wang T, Yang Q. Effect of chemical and organic fertilization on soil carbon and nitrogen accumulation in a newly cultivated farmland. Journal of Integrative Agriculture 2016;15(3):658-666. DOI: 10.1016/S 2095-3119(15)61107-8