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ORIGINAL ARTICLE

How can the agricultural soil support in the climate change mitigation and adaptation?

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ABSTRACT

The rise in temperature over the earth due to the increase in the greenhouse gas concentration in the Earth's atmosphere is defined as "Global Warming". The precipitation and temperature regimes do not continue in the usual order and the meteorological disasters experienced cause people to worry about the future. It also reveals more than just its claims on biodiversity, orientation, and food security. Agricultural production is one of the important sectors that will be directly affected by global warming and climate change, in the light of current information. Food production, which enables people to survive, takes place directly through agriculture. In today's conditions, it is unthinkable to feed large masses without soil. The soil provides all the necessary nutrients to humanity, but only if it is sufficient. Soil health is at the forefront to produce ordinary food. Although what can be done is limited, practical measures should be taken by making projections on climate change. In addition, mitigation and adaptation studies should be carried out for the continuity of agricultural production activities. Due to the slow progress of these mitigation and adaptation strategies, green pursuits for faster action are on the top of the agenda. The pursuit of green has become a powerful weapon in the transformation of rural areas. As an extension of the Paris Agreement, the Green Deal has come to the fore as a strong effort and discourse that the European Union (EU) aims to spread environmental concerns to all policy areas. The agriculture part of this discourse includes "From Farm to Table Strategy" and "Common Agricultural Policy". In this study, the place and position of the European Green Deal in the harmonization process of the effects of global warming and climate change on agricultural soils are also examined.

Keywords: Global warming, climate change, agricultural land, adaptation, mitigation

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1. INTRODUCTION

Increasing productivity is the main goal in the agricultural sector. In the changing environment with climate change, productivity decreases. The negative effects of agriculture on the environment can be reduced through sustainable approaches. along with this, an increase in product efficiency is achieved (Rosenzweig and Hillel, 2008). Instability observed in the climate regime may cause a change in the current production order (Lin et al., 2015). Thanks to the growth of agricultural production, food security can be increased, and poverty can be reduced. Variability in environmental factors can adversely affect soil fertility and the diversity of microflora and microfauna communities. It is now well known that high concentrations of Greenhouse Gases (GHGs) accumulating in the Atmosphere, which cause climate change, can affect agricultural production (IPCC, 2007a). From the Industrial Revolution to the present, human activities have led to an increase of more than 40% in the CO_2 concentration in the atmosphere (Blasing, 2014). The impact of agriculture and farming practices covers more than 14% of total greenhouse gas emissions (Varanasi et al., 2016). Traditional farming practices cause more than 70% of nitrogen oxide emissions. (Burney et al., 2010). These negative effects can be reduced with modern technologies such as precision farming practices and supplementation of bio-based products. The focus of these applications is the use of technologies that promote processes that increase the sequestration of greenhouse gases through soils and plants (Mueller et al., 2012; Johnson et al., 2014). According to the Intergovernmental Panel on Climate Change (IPCC), climate change is defined as any change in climate over time due to natural or human activity (IPCC, 2007a). The IPCC has accepted the increase in the concentration of greenhouse gases (CO_2, CH^4 and N_2O) in the atmosphere as the main factor of global climate change (IPCC, 2007a). The melting of glaciers, rising sea level, increasing air temperature, long-term drought, and frequent observation of tropical storms since 1950 are among the events experienced because of global climate change. The surface temperature will increase by 1.8 - 3.6 °C by 2100; As a result, it is predicted that situations such as intermittent floods, drought and extreme temperatures will occur (World Bank, 2008). Such abiotic and biotic stress factors in climatic conditions can cause significant losses in agricultural product productivity (Ramegowda and Senthil-Kumar, 2015; Pandey et al., 2017; Waqas et al., 2019). This situation can cause delay in seed germination, growth retardation, inhibition of photosynthesis, nutrient deficiency, insufficiency in fertilization, etc. (De Storme and Geelen, 2014; Dresselhaus and Hückelhoven, 2018)

The ecological crisis, which has become more visible with the global climate change, has brought and will bring many green discourses and policy tools from ecology to economy, from economy to politics. Environmentalism and the green movement, which stands out as activism, have turned into a very serious sanction tool by the European Union (EU). This tool is the search for an alternative way of life of economic growth, which cannot be waived, and the search for a new normal in which the new social order can exist. For new pursuits, the idea of green is always promising. The idea of green is the manifestation of green thinking, and the starting point of green thinking is the respect for nature. Europe, which pioneered the Green Consensus, is the continent that also constitutes the primary source of green thinking (İmga and Olgun 2017). In addition, the environmental crisis of global climate change cannot be solved by economic or ecological struggle alone. Therefore, with a holistic perspective, it is possible to state that the common point of the search for green solutions from economy to space is carbon management.

2. THE IMPACT OF CLIMATE CHANGE ON AGRICULTURE

It is stated that the most probable main cause of global warming is the increase of greenhouse gas concentration in the atmosphere, which is the result of economic activities, above the required level. As a result of the gradual warming of the planet with climate changes; It is stated that the melting of glaciers, the rise of sea level, the change of regional and local precipitation movements, the occurrence of extreme weather events, the disappearance of some plant and animal species due to the change of ecosystems, the increase in undesirable natural events such as floods, storms, hurricanes, tornadoes and droughts. Agriculture, food, livestock, fisheries, forestry, trade, tourism and health are among the sectors that are mainly affected by climate change. Among these sectors, agriculture has an impressive role economically, as it is the sector that produces essential foodstuffs for the continuation of activities depending on nature and for the survival of humanity. Processes such as tillage, fertilization, chemical control to obtain a product, conversion of agricultural lands, energy use, animal fertilizers are stated as conditions that affect carbon emissions (Bayraç and Doğan, 2016). It is emphasized that increasing temperature and precipitation rate, changes in the amount of CO_2, the formation and severity of climatic movements that we are not accustomed to for our world and humanity, and increases in sea water level negatively affect the agricultural sector. In addition, it has been reported that this situation changes the existence of living organisms in the soil, the amount of humus in the soil, soil erosion, the flow of nutrients that are beneficial for the development of plants, the living things adapted to the region where they live, the development of plants and the amount of product (Durak and Ece, 2007). It is also reported that global climate change may cause changes in the distribution and diversity of plant and animal species, cause extinction of species and loss of biodiversity (Schaller and Weigel, 2007; Dellal, 2008). In a study conducted in China between 1980 and 2010, by using agricultural data, factors other than temperature and precipitation, especially humidity and wind speed, have negative critical effects on the development and yield of rice and wheat plants, and also ignoring these variables can affect the yield of climate change. It has been stated that it may cause more harm than expected (Zhang et al., 2017). In identifying the impacts of climate change and variability on agriculture and food security in Kenya, the country's heavy reliance on rain-fed agriculture, with seasonal changes in precipitation and varying temperatures and durations, negatively affect crop production and food security for already vulnerable communities in arid and semi-arid regions. reveals the opinion that it will continue to affect it (Kogo et al., 2020). Wheat, barley, sugar beet, poppy, chickpea, tomato, watermelon and various fruit and vegetables are among the most grown agricultural products in Uşak in our country, and yields are 10-20% higher than the average of Turkey. However, in a study conducted between 2000 and 2008, it was reported that there was a decrease in the yield of wheat, barley, oat, corn, tobacco, poppy and chickpea plants. When the morphology and physiology of the plants were evaluated in general, it was stated that there was a decrease in germination rates, short plant heights, early yellowing of leaves, shortening of vegetation period, decrease in seed yield, number and weight, and it was stated that climate change had negative effects on the yield of agricultural products throughout the province (Kara et al. et al., 2010). Another issue that we have faced as a country recently is the decrease in groundwater levels due to the decrease in snow and rain precipitation, and thus the drying up of our rivers and lakes. In this case, it will harm the agricultural sector, which is of great importance for the economic development and development of our country, and Turkey will face the danger of a food crisis and drought. In such a situation, it has been reported that there will be yield losses due to drought in Çukurova and other similar regions where irrigated agriculture is applied (Şahin, 2007). Since climate change is a factor that negatively affects the survival time, reproductive activities and habitats of living things, it is stated that, for example, the body temperature of insects changes according to the temperature of the air and the environment, and the changes that will occur in climatic conditions together with global warming will cause some important differences in the physiology and geographical distribution of insects. It has been reported that changes in temperature and humidity factors affect the functions of insect metabolism, reproductive capacity, feeding activities and also their distribution (Akbulut, 2000). In a study conducted in Kayseri and its surroundings, it was stated that the nectar and pollen resources that bees can benefit from to raise young are scarce, especially in the early spring months, and in recent years, the local beekeepers have reported that the blooming and nectar secretion periods have changed with the changing weather events, and consequently the honey yield has decreased and there have been problems. have reported. For this reason, it has been reported that it becomes inevitable to feed the bee colonies with additional feed in spring in order to produce more offspring and enter the nectar flow more strongly (Bekret et al., 2015).

3. EUROPEAN GREEN CONSENSUS

Reconciliation is literally defined as the harmony, agreement, or compromise between the parties on a certain issue (TDK. 2021). Its main starting point is absolutely to reduce the impact of global climate change. According to EU strategies, the biggest statement of the agreement is the goal of being the first climate-neutral continent in the world. In some studies, although the climate-neutral target is passed as a carbon-neutral target, it represents the transition to the decarbonization process at an individual, institutional and national level, which causes greenhouse gas emissions. The increase in environmental degradation due to climate change causes ecosystem losses. In this direction, the EU has created the "A European Green Deal" framework with the approach of turning an emergency crisis into an opportunity for its countries and citizens. The European Green Deal is a new growth strategy that aims to transform the European Union countries into a fair society with a resource-efficient and competitive economy without net greenhouse gas emissions by 2050 (European Commission, 2019). The Consensus is a new initiative born on the green economic order as a supporter of the Kyoto Protocol in the past and the Paris Agreement in the current conjuncture. In the current situation, accelerating the transformation that has taken place at a very slow pace, with a widespread and slow-to-defective progress, is one of the most important elements in establishing the consensus. This initiative is not just an environmental strategy, as it includes 'green', Yeldan et al. as (2020) stated, it is a sanction argument for the revision of the new international trade system and the sectors that affect the global climate change. European Green Consensus is referred to as the "EU New Green Deal" in some sources. Therefore, it is based on the goal of holistic and reorganizing the systems. This change in order comes to the fore as an effective power in the fields of industry and trade. Consensus is accepted as a rewriting of the next generation trading system rules and a new generation growth strategy and is characterized as a kind of next generation industrial revolution. Since mitigation efforts will create significant stress in Europe, it is of great importance that they agree and be consistent in other countries. For this reason, effective transformation of Turkey in this process is also on the agenda of the Turkish economy as a transition that must be implemented in terms of both not experiencing loss in the import market and contributing to global climate change. The European Green Deal has two main objectives: short-term and long-term. While the short-term goal is to reduce greenhouse gas reductions by 55% by 2030 compared to 1990, the long-term goal is to reduce net greenhouse gas emissions to zero by 2050. The biggest and most striking statement of the consensus is the goal of becoming a climate neutral continent by 2050. The EU supports the agreement with four key components in the transition process: (i) providing financial support, (ii) setting new targets, (iii) leaving no country behind, and (iv) increasing adaptability. 2030 targets have been established for eight reconciliation action areas (Figure 1).

After the publication of the Green Reconciliation strategy, the published and updated policies related to the agricultural sector were "From Farm to Fork Strategy" and "Common Agricultural Policy".

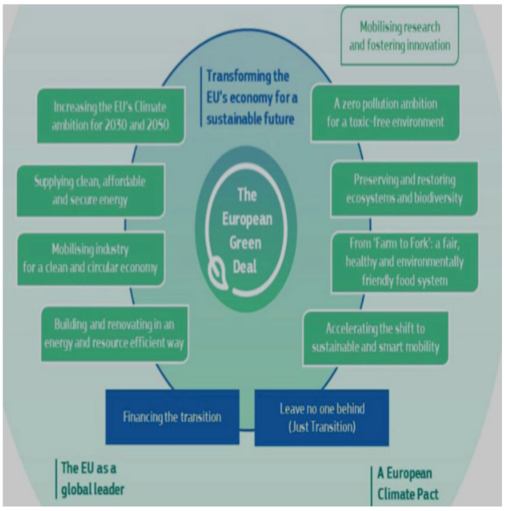

Figure 1. The various elements of the European Green Deal

3.1. Farm to Fork Strategy

From Farm to Fork Strategy; It aims to reduce the environmental impact of the food processing and retail sectors by taking action on transportation, storage, packaging and food waste. The Farm to Fork Strategy includes actions to combat corruption in the food sector, including strengthening implementation and research capacity at EU level, and identifying/developing new innovative food and feed products, such as algae-based seafood (European Commission, 2019b).

3.2. From Farm to Fork Strategy;

1. Reducing the use and risk of chemical pesticides by 50% by 2030,

2. Reducing nutrient losses by at least 50% without any reduction in soil fertility and reducing the use of chemical fertilizers by at least 20% by 2030,

3. Reduction of antimicrobial sales by 50% in livestock and aquaculture by 2030,

4. Organic farming on at least 25% of agricultural lands by 2030,

5. It includes targets for all rural areas to have fast broadband access by 2025 to enable digital innovation.

3.3. Common Agricultural Policy

The European Commission aims to make the system more responsive to current and future challenges such as climate change, while continuing to support European farmers with its Common Agricultural Policy (CAP). CAP provides financial support to farmers (European Commission, 2019). The total EU budget is €161.7 billion and plans to spend €58.4 billion (36.1%) on CAP. Major Common Agricultural Policy objectives are (i) providing a fair income to farmers, (ii) increasing competitiveness, (iii) rebalancing power in the food chain, (iv) climate change mitigation, (v) environmental care, (vi) landscapes and biological preserving diversity, (vii) promoting generational renewal, (viii) preserving vibrant rural areas, (ix) preserving the quality of food and health. Farmers, agri-food businesses, foresters and rural communities;

1. Build a sustainable food system through the Farm to Fork strategy;

2. Contribute to the new biodiversity strategy by preserving and enhancing the diversity of plants and animals in the rural ecosystem;

3. To reach the net zero emission target in the EU by 2050, the Green Deal has an important role in many key policies such as contributing to climate action (Maçin, 2021).

4. APPROACH TO REDUCING THE GLOBAL WARMING POTENTIAL: CARBON SEQUESTRATION IN AGRICULTURAL SOILS

The most disturbing event for the scientists today is Global Climate Change and its impact on various ecosystems and humans after all. With the meetings that have been arranged by internationally and the activities of environmentalist organizations since 1996, the issue remains its importance and never lost its actuality when considered its effects. There are 3 gases (GHGs) that can be associated with agricultural activities: carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). Seven percent of total GHGs emissions (401.0 Tg-CO_2 equivalent value) which was estimated by Turkish Statistical Institute (TÜİK, 2012) by using International Clime Change Panel guide, occurred by agricultural activities. When considered on the basis of GHGs, 4% of 2010 total CO_2 emission, 30% of CH_4 and 74% of N_2O

occurred by agricultural facilities. While CO_2 constitutes the most important GHGs problem on the basis of sector, when considered in view of animal production the most important GHG for the agriculture is CH_4, and when considered in view of plant production, it is N_2O. According to the IPCC Fourth Assessment Report, emission of greenhouse gasses generating from agricultural activities constitutes the 10-12 percent of total GHGs emissions across the globe (IPCC, 2007a). Greenhouse gas emission by forestry was reported as 17.4% (IPCC, 2007b). GHG emissions generating from forestry sector can be seen because of deforestation rather than forestry activities.

In view of carbon dioxide emission, agricultural activities and soil have a great importance. Because agriculture sector performs the function of sequester (store) as well as performing CO_2 emission (source, pool). Recent research have been performed towards the purpose of decreasing CO_2 emission and increasing C-sequestration potentials of agricultural soils. Increasing the C-sequestration rate has a great importance for storing CO_2 in agricultural soils, wetlands, and forests.

When CH_4 and N_2O is compared, high amount CO_2 is subjected to a loop by means of agricultural activities. While plants consume high amounts of CO_2 with photosynthesis, all plants which are used as food, feed and fuel start to decay and turn back to CO_2 with consuming. While the C-loop in agriculture is considered, amount of CO_2 emission occurred due to agricultural activities is low and the resource of this emission is the energy use during the process of agricultural products and transportation.

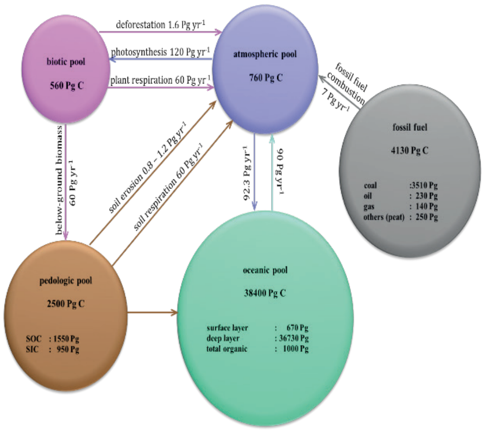

Figure 2. Principal global C pools and fluxes between them (Adopted from Lal, 2008)

Five main carbon pool can be stated all around the world. (Figure 2). The biggest C reserves oceans are followed by fossil fuels, pedologic (soils), biotic and atmospheric pools. All these pools are related with each other, and C changes occur among them. When 560 Pg level biotic pool and 760 Pg level atmospheric pool are compared, global C-pool is quite high with 2500 Pg (1500-1550 Pg organic C [SOC], 950-1000 Pg inorganic-C [SIC], to 1 m depth). (Lal et al. 1998a; Lal, 2008). Main compound of organic carbon pools of soils is mostly active humus-C and slightly inactive coal-C. When the sub compounds of this mixture are analysed, (a) plant and animal residues at various stages of decomposition; (b) substances synthesized microbiologically and/or chemically from the breakdown products; and (c) the bodies of live micro-organisms and small animals and their decomposing products (Schnitzer, 1991). Inorganic C-Pool (SIC) includes elemental-C and carbonate minerals (calcite, dolomite, and compound products of primary and secondary carbonates). Primary carbonates occur with the weathering of main material. Conversely, secondary carbonates occur with the transformation of CO_2 (H_2CO_3) to carbonic acid in soil air with water in soil solution and with its interaction with calcium (Ca+2) and magnesium (Mg+2). Inorganic C-pool is an important compound of the soils in especially arid and semiarid climate areas.

4.1. C-sequestration mechanism in soil

This process of transfer and secure storage of atmospheric CO_2 into other long-lived C pools that would otherwise be emitted or remain in the atmosphere is called "carbon sequestration" (Lal, 2008). Non-sequestrated CO_2 will stay in atmosphere and will continue to be oscillated through atmosphere. C sequestration realizes naturally and human-oriented (anthropogenic). The purpose of anthropogenic C sequestration process is to balance global C supply. This balance is based on "C neutral" strategy in which no net gain is acquired for the C atmospheric C pool. Main purpose in this strategy is to sequestrate anthropogenic CO_2 as almost safe, acceptable in view of environmental aspect and stable techniques with low risks of leakage. There are different technological options which aims at sequestrating atmospheric CO_2 in different global pool like injection to the oceans, geologic injection, mineral carbonation (abiotic) and sequestration by oceans, terrestrial sequestration, and secondary carbonate formation (biotic) (Lal, 2008). The choice of one or a combination of several technologies is important for formulating energy policies for future economic growth and development at national and global scales.

To the process in which atmospheric CO_2 is added to biotic and pedologic C pools is called "C sequestration in terrestrial ecosystems". In these systems, "biotic C sequestration" which is different from management systems that decrease or balance CO_2 emission, is based on the organization basis of removing of CO_2 in atmosphere by high plants and microorganisms.

4.2. Impact of field usage state on CO_2 emission

As a result of changes made in the event of field use, some changes in the organic substance number of soils can be observed. As the result of transformations made towards to arable field usage, a rapid decrease in the organic substance content of soils, in other words, an increase in the CO_2 emission of soils C pool to atmosphere. (Jenkinson, 1991; Paustian et al., 1997). In the arable lands around the world, it is stated that loss in the soils' organic substance is 0.6 C per year. (Dalal and Carter, 1999). In the Amazon area in South America, it can be stated that 5% of soil organic-C in the surface is lost every year because of the grass-pasture rotations of the forestlands. (Neill and Davidson 1999). In research made in the west parts of Nigeria, it was determined that organic substance content in 0-10 cm surface decreased from 2% to 1.4% because of the rotation in arable lands in 10 years period (Lal, 1996). When similar research is summarized, a decrease at the rate of 50-70% in the organic substance content due to the cultivation.

4.3. Global soil erosion and C dynamics

It is quite difficult to predict the total amount of C which change place from topsoils with erosion. Total sediment transportation to oceans by means of rivers is nearly 19 pg yr-1 (Lal, 1995). Erosion rate in arable lands is 3-4 times more than the rate in grasslands. When eroded soils are considered, water erosion is 1.3 Pg, and wind erosion is 0.3 Pg (Oldeman, 1994). If transportation parameter is assumed as 10% (Walling and Webb, 1996), total sediment change from eroded fields can be predicted as 16 Pg yr-1. It can be assumed that transported soil organic carbon is 3% which is equivalent to 0.5 Pg C (Lal, 1995). As a result of the application of soil protection measures, a loss with the amount of 0.1 Pg C yr-1 in the wake of accelerated erosion can be prevented (Lal and Bruce, 1999).

4.4. Renewing of disturbed soils and C sequestration

Renewing of disturbed soils because of the economic and environmental causes is very important. With the improvement of these soils, organic-C content of soils will increase, and soil quality will be better. In nearly 2 billion ha wide total disturbed fields, those which are exposed to heavy erosion is 250 Mha (Oldeman, 1994). Nearly 100 Mha field is exposed to heavy erosion in the view of agricultural fields. These fields are not appropriate for the agricultural activities. But with the right planning, appropriate bushes and tree varieties can be cultivated in these areas with organic and inorganic manure use. Besides the intensification of agricultural activities and implementation of best management practices to these areas primarily, with the afforestation and other renewing measures, improvement of heavily disturbed fields can be achieved (Cole et al., 1995). With the recycling of heavily disturbed topsoils, C- sequestration potentials can be increased to 0.025 Pg-yr-1. Another important strategy about disturbed topsoil is cultivating specific plant kinds which are used in biofuel production in these fields. Biofuels which are directly burned for energy production, can be used in the place of fossil fuels. As a result of the production of appropriate kinds in different ecologic areas, 5 Mg ha-1 yr-1 C assimilation can be achieved (Lal et al., 1998b).

Disturbing of topsoils can occur with another way. Saline soils include the 1/10 of mainland in the world (Szabolcs, 1998), 1/3 of the arid and half arid climate areas, (Rengasamy, 1998) and 930 Mha area all over the world (Sumner et al., 1998). These soils which have many structural defects and imbalance between water and salt, restricts the herbal production. It was reported that with the help of adopting appropriate improvement techniques, there can be achieved a significant betterment in the carbon content of soils (Gupta and Abrol, 1990; Singh et al., 1997; Garg, 1998). Even a smaller increase in 0.2 – 0.3 Mg C ha-1 yr-1 level which will occur in organic-C content because of the evaluation of the saline soils' improvement is important.

4.5. Conservation tillage and agricultural waste management

Many application ways of conservation tillage (CT) can be found like zero-tillage, reduced tillage, mulch tillage, chisel plowing. Among many benefits of CT, soil organic carbon increase when passing on CT from traditional soil cultivation system can be counted (Carter, 1994). In Lal's (1997) research predicted that the size of globally arable lands under CT could be reached to 120 Mha from 1995 to 537 Mha in 2020, that's to say, total increase in 25-year period would be 417 Mha. When the C increase that will be emerge in 25-year period is supposed to be 0.2 Mg ha-1 yr-1, soils C sequestration potentials of the soils will be nearly as 0.08 Pg yr-1 as adopting and applying CT systems. Adoption of conservation tillage may also save fossil fuel at the rate of about 8 Kg C ha-1 yr-1 (Paustian et al., 1997; Lal et al., 1998b).

Crop residue management is a complementary compound of CT systems. Crop residue produced amount all around the world is nearly 3.5 Pg yr-1 (Lal, 1997). Additionally, number of weeds and other biomass in agricultural fields nearly 0.5 Pg. As a result of transforming 2 Pg crop residue which contains 40% C to (0.8 Pg C) soils and 10% of its' transformation to constant humus, additional 0.08 Pg increase to C sequestration potential with the help of herbal residual management will occur.

4.6. Improved farming/cropping systems

The importance of adoption best management practices for the purpose of increasing agricultural efficiency and plant production is vital (Cole et al., 1995). Some best management practices can be summarized as headlines as below:

1. Soil fertility management,

2. Organic manures and byproducts,

3. Water management,

4. Improving product efficiency,

5. C sequestration potential of agricultural areas.

5. CONCLUSIONS

The European Green Deal is very important for the struggle in the climate-environment relationship within the scope of the strategies planned to be implemented. It plays a central role in the Sustainable Development Goals by 2030 (Bouma et al., 2019). By 2050, soils in particular play a key role in achieving the goal of a climate neutral EU. As a carbon sink, soils play an important role in reducing greenhouse gas emissions and are therefore an important element of the new EU Climate Law. In addition, soils have a large biodiversity pool and have been included in the Biodiversity Strategy 2030 (Jeffrey et al., 2010). The Biodiversity Strategy fully addresses sustainable soil management as it has ambitious goals such as increasing organic farming, planting trees, reducing pesticides, and minimizing land tillage. Our soils are the foundation of agriculture and therefore play an important role in the EU Farm-to-Fork Strategy. Sustainable land management strategies that have continuity will be difficult to stick to, given some conflicting goals and objectives. We need to be able to create a coherent framework and make improvements for our future. A coherent framework would be a revised EU Soil Thematic Strategy, which considers the aims and ambitions of the European Green Deal.

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