Soil Health and Quality in Sustainable Agriculture

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***Abstract*—** In agricultural production activities, soil is the most basic production tool and the common value of all living things on our planet with its numerous functions in the ecosystem. Conventional agriculture techniques and monocultures which are applied with rapid population growth throughout the world, increase the pressure on agricultural lands even more, causing regression in their functions and loss of productivity and inequality in access to food in societies. In order to achieve the targeted production in sustainable agriculture, the protection of soil quality and health is accepted as the basic requirement. In sustainable agricultural practices, it is necessary to use the soil at a level to meet the basic needs of people, and to consider the environmental values and to apply the agricultural practices also including alternative agricultural techniques at an optimum level to protect the soil quality. It is considered that the sustainable use of soils depends on the effective use of analysis

***Index Terms*—**Sustainable Agriculture, Soil Quality, Soil health

I. ECOLOGICAL PROPERTIES AND FUNCTIONS OF SOIL

Soil is a dynamic and unique living space that contains a large number of elements in a heterogeneous structure, macroscopic and microscopic dimensions, but rapidly affected by environmental changes. Soil acts as a natural filter for the removal of unwanted solid and gas components from air and water, and recyclable organic substances. The retention and release of water and nutrients, almost all of the life processes of plants and soil organisms occur in the soil, and their biological activity and productivity increase with soil health [1]. Soil microorganisms are living groups with significant effects on soil efficiency and crop production that catalyzes numerous biochemical reactions in the soil and is an important indicator of soil health and quality. Decreased soil organic matter and mineral-based plant nutrition management in monoculture production systems causes a rapid decrease in the activity of soil organisms and ultimately a decrease in plant production.

II. PROBLEMS OF WORLD AGRICULTURAL SOILS

The fact that a significant part of the world's land has been used for plant production throughout the known history, factors such as deforestation and severe erosion that the soil has been exposed to, rapid population growth and intensive use of soils for agricultural production in the last century, rapid expansion in greenhouse agricultural areas and monoculture practices have significantly increased the pressure on soils. Since the second
half of the last century, conventional and intensive agricultural practices have had negative effects on the quality and health of soils and on the yield and quality of crop production in general all over the world. Severe erosion, salinization, organic matter reduction, low biological activity in soils and contamination with soil pollutants including various biocides, heavy metals and currently microplastics are some of these negative changes.

It is reported that 33 percent of the world's land has been destroyed, and this may increase to 90 percent by 2050 [2]. Activities carried out without considering natural resources such as soil, water and environment in agricultural production, industrial agricultural methods, monoculture agricultural practices and intensively used agricultural chemicals cause cost increases in production, infertility of soils, pollution of foods and environment and inequality in people's access to food. Today, the decrease in soil quality, as an important process of soil degradation, is seen as an important constraint in ensuring and improving crop production and food security. Various environmental, public health, economic and social problems arise as a result of the inappropriate use of agricultural chemicals, the misuse of land, the gradual decreases in soil productivity due to inappropriate soil management in cultural land and decreases of agricultural and forest lands by soil erosion [3].

III. SUSTAINABLE AGRICULTURE AND SOIL QUALITY

Sustainable agriculture aims to be adequate, healthy and high quality of crop production, to reduce the cost of production by using natural agricultural inputs, to recover waste, to protect the agricultural lands, the environment and the natural resources, the protection of soil health and productivity, and more effective use of soil resources. In practice, it is accepted as a productive, profitable, low input and natural environment in terms of human and animal health [3].The concept of soil quality is considered as the ability of soil to produce agricultural crops continuously and safely and develop human and animal health in the long term without degrading the natural resource base and negatively affecting the environment [4]. In order to reach the targeted production in sustainable agriculture, the protection of soil productivity and soil quality is accepted as the basic requirement [5].

Soil health is defined as a sustainable soil management principle in terms of the ability of the soil as a living system to fulfill its functions in the ecosystem, the maintenance of efficiency in cultural soils, the development of air and water environments, and the protection of plant, animal and human health. Soil health is an important component of soil quality that covers the dynamic elements of the soil in terms of parameters examined [6]. Soil microorganisms are living groups with significant effects on soil efficiency and crop production that catalyzes numerous biochemical reactions in the soil and is an important indicator of soil health and quality. Within the concept of sustainable agriculture, new agricultural practices that protect soil life and fertility, new methods and technologies for mineral and organic fertilization, new

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production techniques in producing healthy food without adverse effects on soil and environment, use of plant species and varieties suitable for soil resources, fight against diseases and pests, production processes and management practices that protect natural life in terrestrial and aquatic ecosystems are evaluated in a holistic manner.

IV. DETERMINATION AND IMPROVEMENT OF SOIL QUALITY

Today, the soil problems arising from various natural or human reasons, especially climate change, have caused focus on the concept of soil quality in agriculture. The determination of soil quality can be used by politicians and public administrators, researchers, broadcasting agents and farmers as a decision-making support tool for low-cost land management practices and as a measurement of indirect soil function that serves the protection of soil health [7]. The fact that the majority of agricultural activities in developing countries consists of small agricultural enterprises is one of the most important factors in the lack of soil analysis awareness among producers. In the soil analyzes with limited parameters for productivity purposes, usually at the beginning of the production period, basic soil specific properties and available plant nutrients are determined. Although these parameters provide important information about the soil, they require detailed analysis and interpretation in solving the problem in low productivity or marginal soils. Soil quality analyzes are mostly preferred by large-scale investors and advanced agricultural enterprises.

Soil analysis is based on the selection and interpretation of the relevant analysis parameters according to the targeted purpose. Generally, in soil tests for productivity, soil analysis as a process includes various work and procedures from sampling to the creation of recommendations. Effective communication between farmers and the laboratory is of great importance in the creation of accurate recommendations according to the aim of evaluating soil analysis and results. In order to provide the targeted benefit in soil analysis, well-identification and correct sampling information about production and land conditions are among the most important criteria. The correct analytical methods for fertilization purposes are selected and the results of meticulously completed analyzes are evaluated together with the information about the existing production conditions and the type, form, quantity and timing of the fertilizers to be applied are determined and effective recommendations are created. In soil quality analyzes, the original and dynamic features of the soil are analyzed and each parameter is scored, the rating corresponds to a proportional assessment score according to the existing soil characteristics and the results are comparable. In the assessment, the strength/weaknesses of the soils are determined; and at the same time, dominant soil problems and possible effects and suggestions for the use of measures can be developed. Quality tests are used as an effective and comparable method in solving soil problems, especially in land use planning and reclamation of problematic lands, by evaluating the large number of data.

Due to the variability of soils depending on climatic conditions and geographies, there may be differences in the analysis of soil parameters and their evaluations. In general, different methods have been developed according to the regions in the analysis of available plant nutrients, taking into account parameters such as pH, lime, and amount of exchangeable bases in the soil. Different evaluations can be made in the interpretation of the analyse results and in reporting fertilization recommendations for the region-specific plants, as well as specific to the methods used.

Agricultural areas, healthy soils, water resources and plant genetic resources are the basic inputs for food production, and the increasing famine of these resources in many parts of the world necessitates sustainable use and management. Increasing the yield in existing agricultural lands through sustainable agricultural practices and the remediation of degraded agricultural areas will significantly alleviate environmental pressures such as destroying forests for agricultural production and opening new agricultural land. It is accepted that the most optimum methods to improve or maintain soil quality are alternative agricultural practices such as crop rotation, recycling of agricultural operating wastes and animal fertilizers, reducing the use of chemical fertilizer and biocides, and more use of cover plants, green fertilizer products and nitrogen -detecting legumes [8]. These applications protect the soil from erosion and nutrient leaching, while soil helps to protect the organic substance at a high level that facilitates tilling, increases efficiency and productivity and improves soil health.

V. SOCIAL INTEREST AND NEW DEVELOPMENTS IN THE CONCEPT OF SUSTAINABLE AGRICULTURE

Today, consumers all over the world have become sensitive to the quality of agricultural products, their effects on the environment during the production process, and the effects of products on health. The United Nations Sustainable Development Goals include “Ending hunger, ensuring food security and improved nutrition and promoting sustainable agriculture” [9]. Considering the expected changes in temperatures, precipitation and pests in connection with climate change, research, development and technology investments are required to improve the sustainability of food systems. In the future, it is seen that sustainable agricultural practices and the improvement of soil quality that constitute the basis of food safety and good nutrition for everyone in the future and to maintain food safety are critical. In this context, it is seen that there is an increasing interest in the subject in agricultural sectors and political institutions in the world in recent years. A large number of multidisciplinary studies are carried out in agricultural research, and new interdisciplinary departments are established in the academy, increasingly providing "Sustainable Agriculture" training. Today, advanced fertilization methods, plant nutrition and soil management, new biotechnological applications such as the use of bacteria and fungi to increase the efficiency of plant nutrient use, and various smart agriculture practices and practices are among the hopeful applications to maintain health soil life and productuvity of soils.

CONCLUSION

Factors such as global climate change, deforestation, desertification and severe erosion change ecological cycles and cause significant losses in agricultural products in the world. Today, ecological imbalances, environmental pollution and public health problems have emerged due to the pressures of conventional agricultural techniques and monoculture practices on natural resources and the environment. Sustainable use of soils is the main component of sustainable agricultural practices, and it is aimed to protect soil quality and health with a holistic approach in land planning and management. Analysis and evaluation methods are important as an auxiliary tool in terms of monitoring and control in the protection of soil quality and health.

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