Chapter 2
Rhizosphere Engineering and Soil Sustainability: An Introduction

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ABSTRACT

Soils are a vital part of agricultural production. Soil health plays a significant role in the best crop production. Nowadays, our lands are under immense pressure. This pressure may be in the form of climatic changes that affect crop productivity or may be due to population increment that forces our current food system to produce more food to meet consumer needs. Climatic changes affect soil sustainability in the wrong way. Salinity, drought, and heavy metals disturb land structure badly. As the population increases, it dramatically impacts the current production system to fulfill the present needs. In all these situations, agricultural soil sustainability is a challenging factor for soil scientists to make our agriculture sustainable because agricultural sustainability couldn't be possible without maintaining soil health. Many approaches are available to improve soil structure and health. Among these, plant growth-promoting rhizobacterium is a good option. It not only improves soil structure but also helps the plants under abiotic stress conditions.

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SUSTAINABLE AGRICULTURE AND SOIL SUSTAINABILITY: AN INTRODUCTION

As the population is increasing tremendously, our agriculture is under enormous pressure to produce an adequate amount of food for this increasing population. So, our land and agriculture must be sustained accordingly and this can only be possible by the intervention of environmentally friendly techniques. In recent times, our agriculture is facing two types of challenges: firstly, to produce adequate food from the current disturbed system of cultivation and, secondly, sustainable livestock resources. Soil is a vital renewable resource and its sustainability is a more significant challenge for present researchers. Production from soils can be increased by many approaches like utilization of chemicals, agronomic techniques, and overuse of water for irrigation needs that lead to soil degradation. Ultimately, the soil cannot maintain its structure. On the other hand, soil health can also be affected by reducing soil organic matter contents and loss of living organisms in soils. All these things result in adverse effects on ecosystems that diminish the sustainability of agriculture (Meena et al., 2015).

Soil health is the main key factor in fulfilling both challenges of sustainable agriculture and soils (Meena et al., 2016). Excessive use of chemicals in pesticides, insecticides and fertilizer harms soil health. The usage of these chemicals now becomes an essential part of the modern agriculture system, but by using new generation techniques, it is possible to reduce the use of these chemicals without affecting the crop (Mia and Shamsuddin, 2010). Recent studies give a precise interaction mechanism between the roots of the rhizosphere of plants. As the seed starts its germination and the root develops from radicle, the organic matter present in the soil promotes root growth and microbial population in the soil, particularly in the root zone. That is called the "Rhizosphere effect" (Meena et al., 2018).

Rhizobacteria are the key elements that play an essential role in the sustainability of soils. The soils rich in microorganisms have a well-organized soil structure and these soil productions are higher than the disturbed soils. Plant growth-promoting rhizobacteria are currently used worldwide because of their low cost, effectiveness and eco-friendly characteristics. Different factors affecting soil activity include high or low soil temperature, deficit soil moisture, and low pH (less than 5.5) (Aliyu et al., 2013). Besides this, PGPR are beneficial to maintain soil structure and soil health.

By growing human population, food consumption also increases which is observed as a great challenge for agriculture. Besides, climatic change, land degradation and reduced resources like freshwater also significantly affect agricultural production. It has also been observed that by the next ten years, crop yield will be growing at a rate less than 1% and expansion of arable land will be very limited (Alexandratos and Bruinsma, 2012). Overall, food demand is increasing with declining crop production. Sustainable agriculture must meet two challenges, i.e., food security and human health (Godfray et al., 2010). For this purpose, different approaches can be used among which the genetic engineering approach is most important. Thus, the development of stress-resistant crops suitable for the current environmental conditions is significant (Shinozaki et al., 2015). In last two decades, considerable work has been done on the model plant *Arabidopsis* for improving response to current climatic conditions (Zhu, 2016). Now, genetically enhanced plants can be used as main crops in the areas where they are suitable.

Different Approaches to Soil Sustainability

There are many approaches and management methods that have been practiced worldwide for the soil sustainability. Here, we will discuss different strategies that ensure their efficiency, security, protection,