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Legumes and Carbon Sequestration

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Abstract

Food security is a major concern of ever-growing population and their further demands for energy will also become a critical challenge in the years to come and this raise in demand describe why the topic of sustainability is highly concerning. It is furthermost important to sustain land, soil, water, ecosystem and other valuable natural resources for now in order to meet the further coming demands and escaping the risk of insufficiency.

From Agriculture point of view, securing and protecting soil health is prioritized, reducing the usage of fertilizers and energy has always been a point of discussion every now and then and their reduction in usage also lower down the emission of GHG. GHG are the major cause of global warming which leads to raise in atmospheric temperature and disturbing climatic atmospheric and eco-system like factors. The most toxic gas among GHG is $C0_2$. CO_2 gas is major component of globally disturbing phenomenon's lie global warming and depletion of ozone layer; hence it is important to sequester C02 and the very two known methods to do so are biological sequestration and geological sequestration.

Introduction

Carbon sequestration is referred to capturing the atmospheric co2 and storing it in suitable sinks or pools with an aim to achieve global climate change and sustainability, A pool or sink is defined as a natural reservoir in the earth system where elements such as carbon and nitrogen resides in their various chemical forms for a period of time. In case of carbon, it is store as in its organic molecules in living and dead organisms and as a organic matter in soil sequestration of carbon can be achieved through two known processes i.e biological sequestration and geological sequestration.

Agriculture land as a suitable sink

Agriculture lands are potentially one of the most suitable sinks to sequester the atmospheric carbon dioxide and can preserve it for years. Presence of soil organic carbon

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(SOC) will help in improving the soil structure of the soil. Root development and rainfall variation tolerance is also significantly enhanced in soils with improved aggregation from carbon. value of oil carbon Is linked to value for farmer for oil quality and enhancement. It is important in reduction of erosion and sedimentation of water bodies, improvement in water quality., biodegradation of pollutants ad mitigation of climate change but in order to sequester carbon into the soil there should be presence of some organic matter in soil. Here, instead of additional addition of organic matter from outer sources, growing of leguminous crops has always been a better option as it cost less economic value and comes along with several additional properties. Legumes play a very important role in sequestering soil / atmospheric carbon. mychorizae form a symbiotic relationship with plants including legumes by colonizing the roots of the plant. The fungus extends the reach of the plant's roots allowing it to access nutrients and water that may not be available through the plant root alone. This relationship is particularly crucial for legume which require significant amount of phosphorus to thrive. mycorhizae are capable of accessing phosphorus that bound up in the soil making the available to the legume. In exchange for this service the plant provides the fungus with carbohydrate which the fungus uses for energy. The fungus also colonizes these nodules on the plant roots which are responsible for nitrogen fixation. legumes along with mycorhizae help in sequester of carbon from the atmosphere and held it in oil for long periods. When mycohrizae colonize a plant roots, they also secrete a sticky substance called glycoprotein that help to bind oil particle together creating stable aggregates. These aggregates help to increase soil stability, prevent erosion and increase the soil water holding capacity. gromalin play a important role in carbon sequestration.

The glycoprotein is made up of high % of carbon making it an excellent storage mechanism for carbon in soil. The stable aggregate created by gromalin can hold carbon for thousands of years effectively removing it from the atmosphere. According to a model –based prediction by world ban, the cumulative carbon sequestration by pulses in Asia is expected to be 33 .0 mg /ha. legumes also act as ground cover which protect the soil from erosion, erosion process have caused a lot of loss to organic matter too. legumes – based plant residue is needed crop to be incorporated into the soil as it incorporates into the soil as it increase the soil organic carbon (SOC). Ground cover in the inter row of olive trees have proven to be an efficient practice to reduce soil and nutrient losses. Moreover, ground cover can play an important role

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in increasing the SOC, while improving the environmental quality of production systems. The uses of groundcover between row of woody crops, seeded or spontaneous has been extended in the last decade as an environmentally sustainable too to control erosion and reduce pollutants. Over the last 5 years, tests have been carried out comparing different systems of soil management some of the most notable positive results have been seen with no – till and reduced till systems or cultivation with leguminious cover crops. Thus, this conservative practice improves SOC by atmospheric fixation and by the reduction of tillage that increase carbon emission due to the rupture of the soil aggregates. legumes have the potential to reduce the carbon emission during manufacturing of chemical nitrogenous fertilizers by their well own biological nitrogen fixation capacity. The more nitrogen is biologically fixed, More the carbon is sequestered in the soil. Legumes have the capacity to store 30% higher soil organic carbon when compared to other species. but the amount of C sequester by leguminous species totally depends upon legumes species their physiology, morphology, plant biomass, aggregation in cropping system, agronomic interaction during crop period. Higher the SOC, Higher the stability of soil aggregation and structure. Legumes are an imperative component of ecological and nutritional security. Global soils with SOC pools are deteroiting over the years when practiced under intensive –agriculture system.

Legume based cropping systems showed an excellent improvement in maintaining SOC pools even under stressed soil conditions. legumes benefit agroecosystem, soil biology, soil health and productivity. It reduces the leaching effects of fertilizers lie NO_3 by reducing their need as inputs. In recent year several studies have showed that how legume can reduce GHG emission A study by Jeuffroy et al. 2019 showed that legume crop emits around 5 to 7 times less GHG per unit area as compared with other crops. By measuring Nitrogen flux, they showed that peas emitted 69 g Nitrogen which Is far less than winter wheat and rape. A study by x-k guan showed the effect of alfalfa and the local adapted forage legume, bush clover and milk vech on the SOC concentration and SOC stock accumulated annually over a soil profile. the result showed that the concentration of SOC in the bare soil decreased slightly over the 7 years while 7 years of legume growth increased the concentration of SOC.

Involvement of legumes not only improve SOC pools but also serve as a source of numerous ecosystem service.

Direct nutrient transfer

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Direct nutrient transfer Is the transfer of nutrients from a nitrogen fixing legume to another crop during the growth of the crop in an intercrop association with a legume's component as remaining nitrogen for the advantage of a subsequent crop. It is predicted that an amount of the fixed nitrogen by the intercropped legume crop Is made accessible to the accompanying non –legume during the cropping season and the direct transfer of fixed nitrogen from legume to a companion crop , however the degree of nitrogen transfer depend upon the quantity and concentration of legume and microbial mineralization and immobilization in the rhizophere , the availability of other N source and the degree of utilization by the associated crop Is some of the limiting factors.

Nutrient availability and uptake

Nitrogen and phosphorus are the nutrient which are abundant el found in the soil but are present in the forms which are inaccessible to the plants. Contribution or involvement of legume in the cropping system has showed a positive effect on the availability and real chemistry of soil nutrients which has stimulated the availability and uptake of plant nutrients. Peoples and craswell described the benefits of legumes in the agricultural system in following:

- Improvement of soil microbial activity and nitrogen fixing by the addition of leguminious crop residues
- Breaking down the cycles of pests and disease and also breaking the phototoxin and allelopathic effect of different crop residues.
- Improves soil water holding capacity and increased nutrient availability associated with incorporation of legume residues.