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Regenerative Agriculture

A Comprehensive Way to Improve Soil Health and Food Security

1. **Sunanda Biswas**
Division of Soil Science and Agricultural Chemistry, ICAR-IARI, New Delhi
Email: sunandabiswas13@gmail.com
2. **Kalyani Patil**
Division of Soil Science and Agricultural Chemistry, ICAR-IARI, New Delhi
3. **Riaj Rahaman**
Division of Soil Science and Agricultural Chemistry, ICAR-IARI, New Delhi
4. **Priya Singh**
Division of Soil Science and Agricultural Chemistry, ICAR-IARI, New Delhi
5. **B. H. Gawade**
Division of Plant Quarantine, ICAR-NBPGR, New Delhi

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Introduction

A third of the world's soils have already been deteriorated by industrial farming methods, which have mainly prioritized output over resilience and the impact that they have on climate change. This poses a severe threat to the world's food supply. According to a recent FAO assessment, there are currently up to 828 million chronically hungry people in worldwide. Malnutrition, as well as a number of harmful health effects and inadequacies, are caused by hunger. In a warming world with a population of over 10 billion people, agricultural transformation using regenerative and sustainable ways is essential for the food system to provide nutrition and food security. Regenerative agriculture is a holistic farming strategy and land management practice that aims to improve soil health, nutrient recycling, biodiversity, food and fibre security and overall ecosystem resilience by adopting natural processes. One of the key aspects of regenerative agriculture is its emphasis on enhancing soil biological health and microbial activity by integrating ecological and biological processes within the soil environment. Regenerative agriculture leads to healthy soil, capable of producing high quality, nutrient dense food while simultaneously improving, rather than degrading land, and ultimately leading to productive farms and healthy communities and economies (Sahu and Das 2020).

Principles of regenerative agriculture

Reducing Soil Disturbance: Industrial agricultural practices accelerate soil erosion. Therefore, the foremost requirement for soil regeneration is minimizing tillage and reducing soil disturbance. By reducing soil disturbance, regenerative agriculture aims to promote the growth of beneficial microorganisms and increase the soil's ability to retain water and nutrients. This can lead to increased crop yields and improved overall soil health. Additionally, regenerative agriculture helps to sequester carbon in the soil and reduce greenhouse gas emissions, making it an important strategy for addressing climate change.

Covering the Soil: A layer of green crops can protect the soil surface from harmful sun rays and frost and prevent rain from washing it away. It will enhance the soil's water retention capacity, thus accelerating a better nutrient cycle. Regenerative agriculture places a strong emphasis on maintaining and building soil armor, which refers to the protective layer of organic matter on the surface of the soil.

This layer helps to reduce erosion, retain moisture, and promote the growth of beneficial microorganisms.

Ensuring Live Roots in the Soil All-year-round: One of the key principles of regenerative agriculture is ensuring that there are live roots in the soil all year round. This is achieved through the use of cover crops, which are planted between main crops to protect and improve the soil. These cover crops are chosen to provide specific benefits such as fixing nitrogen, improving soil structure, or suppressing weeds. Enhancing the soil's ability to retain water and nutrients.

Practicing Crop Diversity*:* Another key principle of regenerative agriculture is practicing crop diversity. This means growing a variety of different crops on a farm, rather than relying on a single crop. Crop diversity can be achieved through the use of cover crops, crop rotation, and intercropping.

Integrate Livestock: Regenerative agriculture also involves the integration of livestock into farming systems. This means raising animals such as cattle, sheep, pigs, or chickens in a way that is beneficial for the land, animals, people, and the environment.

Fig. Principles of Regenerative Agriculture

Benefits of Regenerative Agriculture on Increased Soil Health and Microbial Activity

Increased Soil Carbon: Regenerative practices significantly increased soil organic carbon levels. Higher soil organic carbon improved soil structure, water-holding capacity, nutrient availability, aeration, water infiltration and microbial activities in the soil (Robertson et al. 2015).

Improved Nutrient Cycling: It includes use of cover crops, diversified cropping, intercropping, crop rotation, stubble retention which significantly improved nutrient cycling in the soil leading to higher nutrient availability for crops and reduced reliance on synthetic fertilizers (Pittelkow et al. 2015).

Increased Soil Biodiversity and Microbial Function: Soil microbes are essential for biochemical transformation of organic matter and nutrient bioavailability. A soil with high microbial diversity is more resistant and resilient to external disturbances (Khangura et

al. 2023). Regenerative practices such as cover cropping, reduced tillage, and diverse crop rotation promote microbial diversity in the soil (De Vries et al. 2019).

Enhanced Soil Fertility: Regenerative agriculture practices help building soil fertility over time by restoring nutrient balance and promoting beneficial soil organisms (Smith et al. 2016). Use of legume as cover crops, can fix atmospheric nitrogen into the soil through symbiotic relationships with nitrogen-fixing bacteria.

Improved Soil Enzyme Activity: Soil enzymes, produced by various microorganisms, play a crucial role in nutrient cycling and organic matter decomposition. Regenerative practices stimulate higher soil enzyme activity, indicating increased microbial involvement in nutrient transformations (Yang et al. 2018).

Disease Suppression: Healthy soils with diverse microbial communities can suppress soil-borne diseases. Regenerative practices that support soil biological health can contribute to reducing the need for chemical pesticides (Mendes et al. 2017).

Sustainable Food Production: Healthy soils with active microbial communities support higher crop yields and reduce the reliance on external inputs, making farming more economically and environmentally sustainable. Beneficial microorganisms in regenerative soils can enhance plant health by aiding in nutrient uptake, producing growth-promoting substances, and helping plants resist diseases and pests (Saeed et al. 2021).

Benefits of regenerative agriculture on food and nutritional quality

A healthy soil microbiome full of necessary bacteria, fungi, and nematodes is more likely to produce nutrient-dense food, promoting better human health (Montegomery et al. 2022). They conducted Several independent comparisons indicate regenerative farming practices enhance the nutritional profiles of crops and livestock. Compared to cabbage from the routinely tilled organic field, the cabbage grown on regenerative no-till vegetable farms contained 46% more vitamin K, 31% more vitamin E, 33% more vitamin B1, 60% more vitamin B3, and 23% more vitamin B5. Additionally, the regenerative cabbage had 74% more phytosterols, 35% more carotenoids, 22% more potassium, 41% more calcium, and 74% more carotenoids.

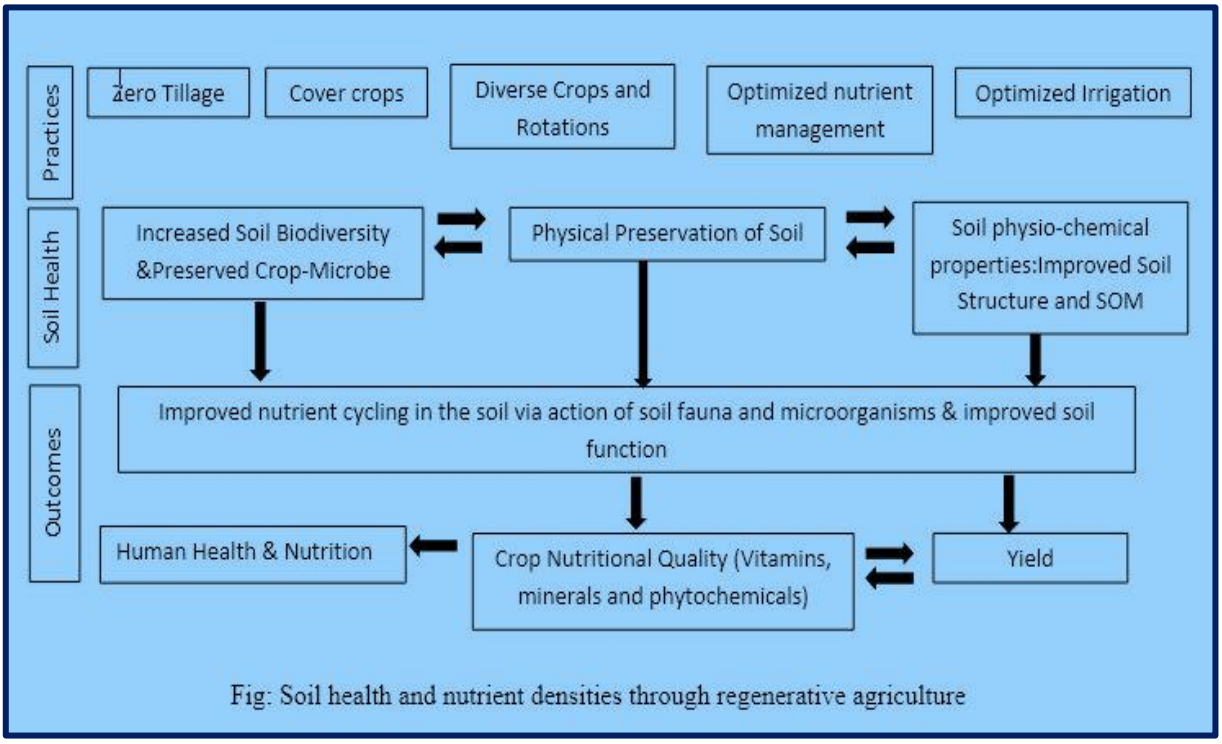

Fig: Soil health and nutrient densities through regenerative agriculture

The impact of regeneration techniques on the mineral density of wheat from two nearby no-tilled farms was compared. With significantly higher levels of boron (41%), magnesium (29%), calcium (48%), zinc (56%), and molybdenum (4 times more), as well as more potassium (26%), manganese (35%), and only two-thirds as much nickel as conventional plots, the cover cropped wheat samples had higher mineral density. Overall, the wheat collected from the regeneratively managed plot had higher mineral micronutrients.

Alpha linolenic acid (ALA), an important omega-3, was present in greater quantities than 6 times (3 times) in the beef from the regenerative farm compared to conventional cattle. More than 9 times as much omega-3 fatty acids and 3 times as many omega-6 fatty acids were present in the pork from the regenerative farm, resulting in an omega-6 to omega-3 ratio that was just a third that of conventional pork.

According to research by Zou and Zang (2009), the Fe concentrations in peanut shoots and seed were 1.47-2.28 and 1.43 times higher in regenerative intercropping of peanut/maize than they were in monocropping. The Fe levels in wheat and chickpea seed rose by 1.26 and 1.21 times, respectively, and the Zn concentration in chickpea seed increased by 2.82 times compared to monocropping.

Kangara *et al.* (2023) studied the impacts of RA techniques on the nutritional profiles of the majority of crops. In 15 out of 16 trials, rice produced with more organic inputs had significantly higher grain zinc (Zn) concentrations. In 50% of experiments where plants received more organic inputs and in 76% of studies where plants received insufficient watering, the vitamin C content of tomato fruit rose.

Conclusion

Both agronomists and nutritionists should pay more attention to the processes and connections by which regenerative agricultural techniques affect the nutritional density of food and, subsequently, perhaps human health. Regenerative farming methods based on conservation agriculture provided crops with increased amounts of phytochemicals, vitamins, and minerals compared to conventional farming. Therefore, the adoption of regenerative agriculture helps to maintain soil health as well as sustainable yield and nutritional quality of the produce.

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