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Crop Residue Management in Improving Soil Fertility

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Abstract

The soil is an essential resource for food production. This means that in order to maintain the soil's nutrient cycling, management is needed. Due to the significant nitrogen loss caused by planted crops, the health of the soil is at risk. So, while considering sustainable, healthy soil, one of the factors to consider is crop residue management. By positively affecting soil characteristics and life-supporting processes, crop leftovers that are reincorporated into the soil have the potential to either maintain or improve soil quality and production. Enhancing grain production by transferring crop residue yield to grain has been the traditional goal of crop variety development initiatives. This results in crop residue yields for cereals being lower than those of the unimproved types, and it also frequently creates residues of worse feed quality. Therefore, initiatives to combine the production of food crops and animals are required in order to maximize the utilization of home and animal waste and manure on fields. A major source of nutrient losses from agricultural soils is the removal of harvested products and crop leftovers. Corn stover, sorghum, millet, and other cereal crop residues are the most often used crop leftovers for mulching. The productivity of the following crops was enhanced by the incorporation of agricultural leftovers or residue + manure. The topsoil (0–15 cm) has shown significant pH fluctuations as a result of agricultural residue incorporation. Soil pH has been considerably raised by adding crop leftovers, particularly manure. Application of agricultural residues also promotes dry matter production and nitrogen fixation. Generally speaking, crop residue management is essential to maintaining soil fertility and raising crop productivity.

Introduction

In order to preserve soil fertility, one of the primary issues is the decrease in soil organic matter content and the resulting loss in soil productivity. Nutrient recycling is greatly aided by the addition of organic materials like crop waste. Through positive effects on soil characteristics and life-supporting processes, crop leftovers returned to the soil can maintain or improve soil quality and production. By comparing the results of irrigated rice productivity,

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pest incidence, and soil fertility to the results of applying fertilizer alone, rice straw residues, either alone or in conjunction with in situ grown green manure and straw burning, showed that the residue treatments positively impacted a few soil parameters. Compared to solely fertilizer-treated plots, cycling of crop residues by integration or burning greatly enhances soil accessible K and organic carbon; residue inclusion also increases total N content.

Crop types that guarantee sufficient crop residual output for on-farm feed, fuel, and building materials are cultivated by farmers who raise both crops and livestock. Programs for improving crop varieties have typically centered on increasing grain production by transferring yield from crop residue to grain. This results in lower crop residue yields for cereals and frequently lower-quality feed residues than the unimproved kinds. Crop breeding techniques should take into account farmers' numerous uses of the crop biomass in its entirety, not just the grain.

What is Crop Residue Management?

Crop residue management (CRM) is a tactic that involves increasing the quantity of residue left over from previous harvests while decreasing the frequency and intensity of tillage operations. This management strategy aims to preserve the quality of the soil and water while offering a host of additional ecological and financial advantages. In most cases, the switch to crop residue management is justified by high yields and decreased usage of costly inputs like gasoline, power, and synthetic fertilizers.

CRM often starts with low-residue plants and then moves on to high-residue plants or cover crops. Other important elements of this year-round management, which goes well beyond the post-harvest season, include the volume of leftovers, their orientation (from standing stubble to lying prostrate), and their even distribution throughout the most taxing periods.

Role of Crop Residues

- **Mulching:** Typically, mulching is applied to cereal crops like millet, sorghum, or maize stover residues. This reduces the effects of wind and water erosion on seedling emergence and early growth, breaks up surface crusts and lessens the resistance of the soil to penetration, increases the density of root lengths, increases the formation of stable soil aggregates that improve soil porosity and water infiltration, increases water retention capacity, and lowers the maximum temperature of the soil surface. Moreover, mulching can raise the pH and contribute to relative increases in soil organic matter levels. Mulching

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has been shown to significantly alter soil chemistry in sandy soils, increasing cation exchange capacity (CEC) and P availability. Increases in pH and K brought about by residue mineralization are also significant.

- **Compost Making:** Composted crop leftovers have long been utilized in compost preparation. Crop wastes are piled in dung pits and utilized as animal bedding for this purpose. About 2-3 kilograms of urine are absorbed by each kilogram of straw in the animal dung, enriching the urine with nitrogen. After composting, the leftover rice crop from a hectare of land yields roughly three tons of manure with nutrients comparable to farmyard manure (FYM).

Methods & Practices of Crop Residue Mangement

The most efficient method of CRM is the combination of low-till techniques and soil conservation measures.

- **No till farming** - This method of management involves planting seeds without first tilling the soil and leaving residue on the field. Reducing the frequency of heavy machinery crossing the field reduces soil disturbance. In addition, untended plant waste improves the soil by holding onto moisture, reducing erosion, and providing carbon.
- **Ridge tillage** - In order to allow plant remains to collect, farmers create raised beds or ridges. This lessens soil erosion and increases water penetration.
- **Mulching** – This involves leaving remnants of crop in the soil surface. This helps to stop erosion, save water, and control the growth of weeds.
- **Conservation Practices** - For residue management, cover crops and crop rotation—especially with legumes—are crucial because they not only offer organic matter and nutrients, but also the required field protection. These management techniques can affect the field's nitrogen cycle in addition to reducing soil erosion and degradation.

Impact of crop residues on Soil Fertility

Addition of crop residues in the soil changes the soil physical, chemical and biological properties. The bulk density decreases with increase in hydraulic conductivity by alteration in the aggregate stability by these methods. Crop leftovers left on the soil surface decrease surface crust formation, promote infiltration, and slow down flow by functioning as little dams. When left unaltered with no-till, the channels (macro pores) formed by earthworms and ancient plant roots enhance infiltration to help lessen or completely eradicate runoff. In various farming and

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climatic conditions, less evaporation from the upper soil layers combined with better soil properties basically results in increased crop yields.

Crop residues serve a number of functions for plants, including storing nutrients, preventing nutrient leaching, increasing cation exchange capacity (CEC), creating a favorable environment for biological N_2 fixation, boosting microbial biomass, and improving enzyme activity. Enhanced microbial biomass can serve as a source and sink of plant nutrients, improving soil nutrient availability. Applying crop residues from lower C:N crops, such as legumes, oilseeds, and pulses, can improve soil alkalinity by releasing hydroxyls during the breakdown of residues with greater C:N. Crop residues also play a significant role in reducing soil acidity. Crop residues' contribution to soil carbon sequestration would be advantageous in the context of reducing greenhouse gas emissions and combating climate change.

In conservation agriculture, the establishment and upkeep of soil health are closely related to the successful and efficient attainment of the nutrient management goal. Crop nutrients, particularly P, are layered and built up on or near the soil surface via conservation agriculture. The stable soil structure is facilitated by less tillage and soil organic C build-up; however, this intact structure creates macropores and preferred flow channels that can channel nutrients, including P, into the deeper soil profile. The depletion and/or enrichment of nutrients through crop residues and biomass production, the need for external inputs, and the impact on the environment are only a few of the processes that can be caused by the cropping systems selection.

Conclusion

More efficient use of agricultural leftovers and manure on croplands requires the integration of livestock and crop production. The most effective method for increasing fertilizer use efficiency and maintaining crop output is to use chemical fertilizers in addition to locally accessible organic resources. Therefore, it is essential to enhance the agricultural resource base in order to boost the effectiveness of external inputs and make them a desirable choice for farmers. Implementing integrated soil fertility management could benefit the environment in addition to increasing farm output and farmers' income.

Enhancing soil fertility is essential for intensifying agriculture using more sustainable production methods. To promote the integration and uptake of these technologies and methods, a comprehensive program for managing soil fertility is necessary. This program must include

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the following: managing livestock, using crop residues and manure, providing fertilizers for balanced fertilization and increased fertilizer use efficiency, providing institutional support for the dissemination of technology, and providing market incentives to promote adoption.