



Benefits of Organic Amendment Use in Intensive Agriculture



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Introduction

Bangladesh is an agricultural country. Depletion of soil organic matter is the main cause of low productivity, which is considered one of the most serious threats to the sustainability of agriculture in Bangladesh. In Bangladesh, most soils have less than 17g/kg and some soils have less than 10g/kg organic matter.

Soil management under intensive agriculture needs complex and appropriate practices and all efforts must be made to efficiently contrast soil degradation due to stress conditions of this management. A wide array of organic amendments, having different levels of processing is used. Composts are most frequently used to increase soil organic C stock, provide essential nutrients (such as N and P) and improve microbial populations and activities. In this article, benefits of organic amendments in intensive agriculture systems in terms of enhancing soil quality (physical, chemical and biological fertility) is discussed.

Physical fertility

As widely reported in literature, the use of organic amendments increases soil organic matter [1] and as consequence soil aggregate stability, water holding capacity and soil porosity [2] thus improving soil quality. The application of organic amendments such as sheep manure, cow manure, rice husk, reeds, and wheat straw increased soil aggregate stability and decreased soil bulk density. The latter soil property is strongly correlated to soil organic C, since the

addition of organic amendments normally increases soil organic C and conversely decrease soil bulk density. In a long-term study in China, it was found that farmyard manure and straw application determined a decrease of soil bulk density (1.21 and 1.18Mgm⁻³, respectively) when compared with untreated soils (1.43Mgm⁻³) due to increase in soil organic C and porosity.

Also organic amendments obtained from manufacturing by-products, such as biochar, can affect particle size distribution and aggregate stability. As reported in Liu et al. [3], in agricultural soils under 40t ha⁻¹ biochar, soil water stable aggregate (>0.25mm) in the 0-15cm soil layer had a remarkable increase respect to other treatments, especially the macro-aggregate with particle size larger

than 2mm, suggesting that biochar incorporation into soil improves soil structure.

Sometimes, organic amendments can indirectly affect soil physical properties. Organic amendments containing high amount of bio-available C derived from cellulose, can promote fungal proliferation and improve soil structure through stabilization of soil aggregates, suggesting a use of organic amendments to manipulate soil microbial community structure and to promote aggregation in soils.

Chemical fertility

Intensive agriculture, without organic amendments for the restoration of soil organic C stock, negatively affects soil chemical properties producing a reduction in soil C content, that, in turn, produces deleterious effects on soil microbial biomass, soil enzymatic activities, functional and species diversity, besides a drastic increase in soil salinity. A large body of empirical studies carried out in different agricultural systems demonstrated that the application of organic amendments in the form of compost is an effective tool to recover soil organic C stock (Figure 1). C/N ratio is considered an important parameter to predict organic C mineralization rate and dynamical patterns of the nutrient release. Soil C:N ratios are significantly higher in organic soils than in mineral soils, increasing linearly with soil organic carbon (SOC) content. The main mechanism is related to the behaviour of saprophytic microorganisms in soil: microbes feed on organic matter requiring both organic C and N in a relatively fixed stoichiometric ratio. Organic C or N can limit microbial growth when C/N ratio is above the threshold value of ~25-30. So, when the C/N ratio lies above this threshold, the microbial feeding rate as well as the organic matter decomposition rate rapidly decreases, allowing long-term C storage. However, when an organic amendment with high C/N ratio is incorporated into the soil, mineral N can be temporarily immobilized within microbial biomass, thus impairing plant growth and crop yields. Indeed, a complete N immobilization is not acceptable under intensive farming systems where plant nutrition is tuned to match crop needs.

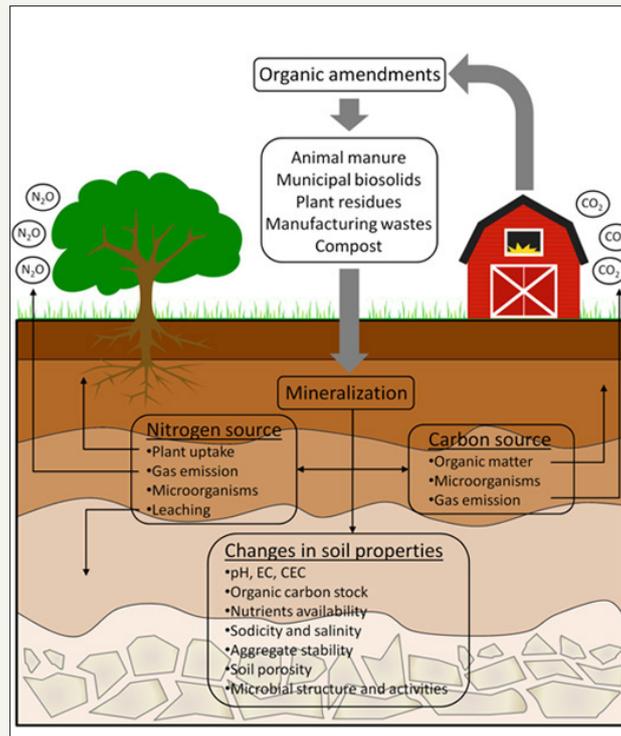


Figure 1: Schematic representation of the effect of organic amendments on soil properties by acting as a source of carbon and nitrogen [4].

Therefore, a crucial step for a sustainable management of soil quality is to identify organic amendments with specific biochemical quality that effectively balance the trade-off between organic C stock recovery and nutrient mineralization. The addition of chemical fertilizers generally leads to a rapid mineral N release, while organic amendments induce a slow mineral N release, but extended over time. The slow mineralization of N in soils under compost amendment improves not only the soil fertility, but also the conditions of organic matter mineralization. Although compost application could promote nitrification process, if compared with mineral fertilization it reduces N leaching, decreasing the possibility of nitrate groundwater contamination.

Numerous researches have been addressed on soil nutrient supply after the application of organic amendments. As a consequence of the application of organic amendments, which increase organic C stock, soil cation exchange capacity (CEC) increases. High values of CEC allow retaining essential nutrient cautions making them available for crop productions [4,5].

Biological fertility

Microorganisms play a key role in decomposition of organic matter. The main factor of soil fertility and agricultural sustainability is the diversity of soil microbial communities which govern the mineralization rate of soil organic C (Figure 1). Organic amendments, once added to the soil, favour the growth and diversity of microbial communities, highlighting a strong correlation between soil biological fertility and soil organic C content.

The use of soil organic amendments as compost affects soil biological properties and enzymatic activities, thanks to the readily utilizable energy sources introduced in soil. Soil biological properties are considered good indicators of soil fertility due to their quick responses to perturbations. They include properties directly related to microbial biomass and activity, and to the decomposition of organic compounds, such as the activity of hydrolytic enzymes.

Many studies provide evidence that the use of compost as organic amendment positively affects soil fertility in terms of biological and enzymatic activities, in particular under intensive farming systems. .

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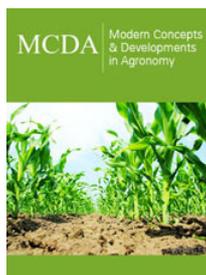
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