EXAMINING SOIL CARBON DYNAMICS TO ENHANCE SUSTAINABLE AGRICULTURAL MANAGEMENT

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1. INTRODUCTION

Overuse of inorganic fertilisers is uncoupling the biologically driven carbon cycle, leading to increased microbial oxidation of soil carbon. Given the environmental impact and increasing economic cost of fertilisers, a sustainable future for agriculture must mean significantly reduced reliance on inorganic fertilisation. Through greater understanding of the carbon dynamics within agricultural systems and the biotic factors which influence them, an enhanced management regime can be developed which will engage sustainable agriculture.

2. PROJECT BACKGROUND

The project will utilise research plots available at the Scottish Crop Research Institute (SCRI), Dundee, Scotland. The associated Centre for Sustainable Cropping aims to establish solutions for the long term viability of Scottish farming. This includes minimum till practices. precision farming, with reduced inorganic fertilizer inputs and increased use of biological fertilizers such as compost and green manure. Investigation of soil carbon dynamics forms a key component of this research.

3. EXPERIMENTAL AGENDA

Three initial studies will be set-up in order to address hypotheses relating to the transfer of carbon through the agricultural system. These are summarised in the following:

MAIZE STRIPS

The experimental area represents agricultural land which has been cultivated with maize for four years. Harvested biomass is returned to the soil annually.

Aim

Using the ^{13}C signature of the C4 maize, soil cores will be analysed to determine microbial carbon sources between treatments and with depth through the soil profile.

Hypothesis

Microbes preferentially use carbon from recent maize inputs in the surface soils, compared to deeper soil horizons where microbes are sourcing carbon from older SOM.

TILLAGE PLOTS

Comparison of 'till' and 'no till' practices evidence apparent gains in carbon at the soil surface of no till plots.

Aim

Crops will be pulse labelled with $^{13}CO_2$ and soils will be analysed to determine the depth-distribution of plant-derived inputs.

Hypotheses

Increased carbon in the surface soil horizon of no till plots is associated with increased root biomass and deposition of ^{13}C. Redistribution of plant inputs to soil is not necessarily evidence of enhanced carbon storage of the whole soil profile.

PRIMING EFFECT STUDIES

The priming effect (PE) is a strong, but short term change in the mineralization of SOM following an amendment to the soil carbon pool. Microbial biomass composition and activity within a soil is considered to be the dominant driver of PEs.

Aim

Applications of carbon in the form of glucose, green manure, and compost will be made to agricultural soils.

Hypothesis

Alterations to the abiotic environment and differences in carbon substrates applied will have varying effects on microbial communities, thus affecting the resulting PE responses.