学位論文審査の要旨

博士の専攻分野の名称　博士（農学）　氏　名　Toru Hamamoto

審査担当者　主査　准教授　内田義崇
副査　教授　波多野隆介
副査　教授　石黒宗秀

学位論文題名

Effect of organic amendment on soil carbon dynamics in agricultural ecosystems

（農地土壌生態系における有機物投入が土壌炭素動態に及ぼす影響）

This thesis of 142 pages consists of 6 sections in the body of text with 325 literatures cited, 25 figures, and 11 tables. One original article is attached as a reference paper.

Soil carbon (C) contents and dynamics are important in the maintenance of health soils. Organic amendments (e.g. crop residue and organic manure) are known as materials to increase soil C. The degradation of organic amendments and physical disturbance of soils, performed by the fauna, can alter soil microbial community, and thus influence rates of the C cycles. However, little is known about the interaction between different soil biological communities (i.e. soil fauna and microbes) regarding soil C dynamics. Hence the objectives of this research were (1) to investigate the effects of different types of earthworms on CO_2 emissions and microbial biomass during organic material decomposition, (2) to determine the effects of organic amendments on above-ground ecosystems in two agricultural soils in Zambia and (3) to quantify the interaction between soil C dynamics and microbial community changes after organic amendments in two agricultural soils in Zambia.

This first experiment measured the changes in CO_2 emissions and soil microbial biomass during barley decomposition with and without earthworms (*Metaphire Hilgendorfi* and *Eisenia Fetida*). After 32 days incubation, *M. hilgendorfi* had a potential to accumulate microbial biomass carbon (MBC) and nitrate-N, compared to *E. fetida*. The result suggested that the interaction between soil microbes and earthworm is influenced by earthworm species, consequently influencing the soil C and N dynamics.

The second experiment investigated the changes aboveground ecosystems after organic amendments (e.g. cattle manure, poultry manure etc.) in two different soils in Zambia. We conducted two field experiments using different organic amendments in sandy loam soils and loamy sand soils in Zambia. A split-plot design was used with crop type (cassava, maize, soybean and control (bare) as the main plot and soil amendment (chemical fertilizer, cattle

manure, poultry manure, maize residue, and control) as the subplot factors. The results showed that the total number of soil fauna in each site was totally different; we found around 1000/200 individuals at sandy loam soils/loamy sand soils. Organic amendments stimulate soil fauna abundance. For crop production, the organic amendments had positive effects on crop yields in both soils. Based on the results, organic amendments largely contribute to stimulate soil fauna abundance with the increase in nutrient cycles in sandy loam soils, while organic amendments act as nutrient source for crop production in loamy sand soils.

Finally, the third experiment focused on the influence of the organic amendments on C dynamics and soil microbes in C depleted agricultural soils in Zambia (same treatments of second experiments). The results indicate that in the loamy sand soil, organic amendments altered the microbial activity but did not have a major impact regarding the C sequestration in the soil. Contrastingly, the effects of the organic amendments on CO_2 emissions and microbial activities in the sandy loam soil were unclear. Factors such as soil texture and moisture ranges controlled the impacts of organic amendments on soil C cycle and bacterial communities. These studies indicate that the response of organic amendments is markedly influenced by soil biological community. Those different response consequently influenced soil C dynamics and agricultural production. To maintain/increase soil C in agricultural systems, the factors affecting the soil biological community have to be taken into account.

As described above, this study investigated the interactions with soil fauna and soil microbes and relationships between soil biological community and C dynamics. The results obtained from the current study greatly contribute to understanding of the effects of organic amendments on soil biological community and soil C dynamics. Therefore, we acknowledge that the author is qualified to be granted the Degree of Doctor of Philosophy in Agriculture from Hokkaido University.