A 10-year Comparative Study of Organic Carbon Fractions and Carbon Storage in Soils Using Organic and Traditional Soil Management Practices in Rice Farming

Suphathida Aumtong* and Paweenoot Pongwongkam

Soil Science Program, Faculty of Agricultural Production, Maejo University, Chiang Mai, 50290 Thailand
* Corresponding author. E-mail address: suphathidaaumtong@yahoo.com

Abstract

The purpose of this study was to investigate and compare the impact of soil management methods applied in both organic rice farming (ORF) and conventional rice farming (CRF) cultivation practices, on the amount of labile organic carbon that can easily be decomposed in the soil, or can be stored as organic carbon in the soil. The participating farmers were divided into two groups: farmers applying organic farming methods (ORF), and those utilizing conventional farming techniques (CRF). Eleven test plots were used in each group, for a total of 22 plots. Each test was replicated 3 times, making 66 physical tests, and each of 22 initial tests replicated 3 times with pseudo replication, giving a total of 99 tests. Carbon fractions analysis in the soil included total organic carbon (TOC) and labile organic carbon fractions (LOC); water soluble carbon (WSC), hot water soluble carbon (HWSC), permanganate oxidized carbon (POXC), carbon in coarse particulate organic matter (CPOM-C) and carbon in fine particulate organic matter (FPOM-C).

The results showed that about 82% of the ORF farmers used straw waste from harvesting for fermentation, to cultivate mushrooms and to feed cattle and water buffalo, and both ORF and CRF farmers also burned the rice straw and stubble. In CRF could affect the amount labile organic carbon (LOC). The amount of various fractions of organic carbon that could easily be decomposed, or called labile organic carbon, in both ORF and CRF were analyzed at a soil depth of 0.30 cm. The results showed that the amount of TOC, WSC and HWSC in the ORF soils were much higher than in the CRF soils. Also, the amounts of POXC, CPOM-C and FPOM-C in the CRF soil were higher than in the ORF soil. A further result was that, in CRF soil, labile organic carbon constituted up to about 82% of TOC, while in the ORF soil labile organic carbon constituted only about 35% of TOC. It was also found that all forms of labile organic carbon were higher in CRF soil than in ORF with levels of CPOM-C > FPOM-C >> POXC >> HWSC > WSC. This trend was found in both CRF and ORF soils. We conclude that ORF soil management practices with regard to rice straw usage and crop residue removal affected LOC, and affects the decomposition and mineralization of the soil organic matter available as a plant nutrient. In CRF, the burning of rice straw and crop residue enhanced the amount of LOC.

Keywords: Organic rice farming, paddy soil, labile organic carbon fraction, crop residue removal

Introduction

Organic agricultural practices include the use of organic substances for soil improvement and pest control, especially emphasizing soil improvement using fertilizers such as manure, compost, fresh green or leguminous crops to increase soil fertility for crop production (Food and Agriculture Organization of the United Nations (FAO), 1995). In this way, there are no negative effects on the environment and the local ecology: i.e. does not reduce bio-diversity (Whittingham, 2011).

In Thailand, the yield from organic agriculture reached 71, 847 tonnes/year and with a value of 1, 914 million baht/year. Rice farming contributes about 44, 005 tonnes/year, valued at about 704 million baht/year (Greennet, 2015). Thailand is a significant producer of organic rice with increases in production estimated at 50% per year. However, only 0.09% of the total area planted to rice in Thailand is organically farmed, while the volume of organic rice produced was only 0.06% of the total amount of rice produced in the country. A large proportion of certified organic crops are destined for export markets, whereas significant volumes of non-certified products are sold in the domestic market. Many growers are export-geared, producing organic rice mostly for the European market (Organic Trade Association, 2006)

To improve or maintain soil quality, increased amounts of organic matter in the soil must be achieved (Leifeld, 2012). In order to be able to evaluate if the organic resources in the soil are sustainable, an index of soil quality that reflects the soil management system, and crops grown in that soil, must be developed (Grigal & Ohmann, 1992).

Soil organic matter (SOM) in the soil can be divided into 2 groups based on considerations of the speed of mineralization of the fertilizers used. One group of organic material includes those materials that are affected by the chemical components of the organic substances in the soil, and the prevention of initial mineralization of inert or recalcitrant organic carbon such as are found in humus or organic substances containing lignin components, or charcoal. These may require more than a hundred years, if not a thousand years, to be dissolved (Krull, Skjemstad, & Baldock, 2004). The second group of organic carbons are those that can be easily dissolved or digested (labile organic carbon, LOC), which includes substances that can be easily transformed, such as carbohydrates, amino acids, amino sugars and lipids, and include organic carbon in the groups of lignin, cellulose, hemicellulose, fat, resin (Tirol-Padre & Ladha, 2004). These organic substances react much faster to various soil management practices, perhaps together with organic explants such as particulate organic matter (POM) (Dalal & Mayer, 1986) or organic matter than can be readily dissolved (dissolved organic matter, DOM). These include water-soluble carbon (WSC) and hot water soluble carbon (HWSC) (Ghani, Dexter, & Perrott, 2003), permanganate oxidized carbon (POXC) (Weil, Islem, Stien, Gruver, & Samson-Liebig, 2003), and others in which the amount of labile organic carbon are important to the decomposition of organic matter in the soil or have a priming effect (PE) (Blagodatsky, Blagodatskaya, Yuyukina, & Kuzyakov, 2010; Kuzyakov, 2010) and have fast reactions to soil management that affect the amount of organic matter retained in the soil (Tirol-Padre & Ladha, 2004).

Paddy soil has an anoxic condition (lack of air) and tends to accumulate organic carbon in the soil (soil organic carbon sequestering) at a much higher rate than areobic soils (Tong et al., 2009). The stabilization of SOM by soil minerals makes it hard for SOM to decompose which can be considered to have a significant and important role in tropical soils. (Nguyen, Varadachari, & Ghosh, 1990) Aside from this, various soil management practices such as plowing, organic waste management, burning of field residues and application of chemical fertilizers or organic materials usually precticed by farmers, may allow the various organic carbon materials to change or transform themselves. This has an effect on the amount and quality of organic substances in the soil by affecting, or controlling, the mineralization or dissolution of the organic substances in the soil (West & Post, 2002). The factors that control the decomposition/mineralization of organic matter include the components of the organic matter type in the soil, the soil structure, and the various organic substances present in the soil (Von Lutzow et al., 2006) and/or the accumulation of organic carbon in paddy soil that is significant for the soil quality and the soil ecology.

The purpose of this study was to investigate and compare the effects of soil management in rice cultivation in both conventional rice faming (CRF) and organic rice farming (ORF), especially the effects on the amount of labile organic carbon which can be easily decomposed, and the amount of organic carbon storage maintained in the paddy soil.

Methods and Materials

Study Area

This study was conducted between November 2013 and May 2014. Twenty-two farms were survey, resulting in 22 farmers being selected for inclusion in the study. This cohort of farmers consisted of 11 farmers who practiced organic rice farming, using Khao Dawk Mali 105 variety (*Oryza sativa* L), and identified as the ORF group, and 11 farmers in the inorganic/chemical group who used conventional rice farming methods (CRF) for RD 6 variety. The study site comprised an area planted to rice under ORF and CRF conditions, 11 test plots in each group, in Ban Don Jiang, Tambol Sob-pueng, Amphoer Mae-tang, Chiang Mai province. General management practices include transplanting of rice during both the rainy season and the dry season, and most of the farmers planted soybeans in rotation every year (e.g. 2003-2013). The participating farmers were interviewed about their soil management practices and uniform soil samples were collected from each farmer (Figure 1). Soil samples were randomly collected from each of the 22 farm sites. Three soil samples were collected at each site, at depths of 0-5 cm, 5-10 cm, 10-15 cm and 15-30 cm: 66 samples in all.

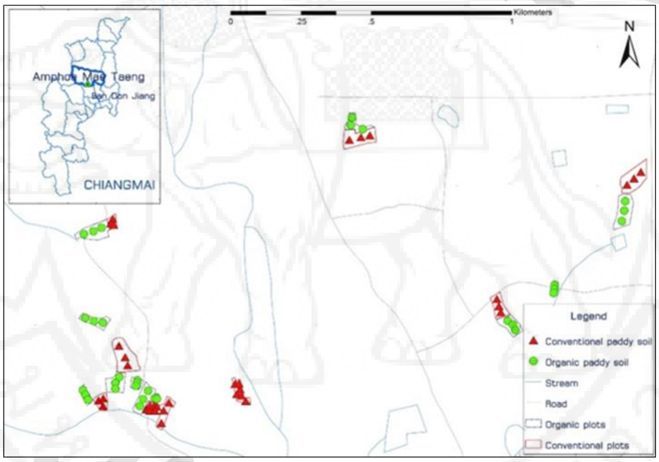

Figure 1 Site study and soil sampling plots from ORF plots (green cycle) and CRF plots (red triangle).

Analysis of Carbon Fractions in the soil samples

Total organic carbon (TOC) was modified by using $K_2Cr_2O_7$ and heated to 130°C then left standing for 24 hours) (Walkley & Black, 1934). For the Water soluble carbon (WSC), the soil samples were extracted with 30 ml of deionized water for 30 min using an end-to-end shaker at 200 rpm at room temperature, then centrifuged for 20 min at 5000 rpm. All supernatants were then filtered through a membrane filter into an Erlenmayer flask for carbon analysis by Cr_2O_7 oxidation (Ghani et al., 2003; Haynes, 2000). For the analysis of the hot water soluble carbon (HWSC), a further 30 ml of deionized water was added into the tube containing the soil samples from the prior WSC analyses. The tube was capped and left for 16 h in a hot-water bath at 80°C. These tubes were then centrifuged for 20 min at 5000 rpm and the supernatants filtered through paper filters (cellulose acetate filter 0.45 μm). Total carbon (inorganic and organic C) in both the first and second extractions was then determined by Cr_2O_7 oxidation (Fynn, Haynes, & O' Connor, 2003). For the permanganate oxidized carbon (POXC), 3 g of air-dried soil was passed through an 0.5 mm sieve with 20 ml of 0.02 M $KMnO_4$ (modified from Weil et al., 2003). Carbon in large particle size fraction (CPOM-C) and Carbon in fine particle size fraction (FPOM-C) were extracted from 30 g of whole soil sample with 100 ml of distilled water by shaking at 20 rpm for 16 hr, and the slurry was poured into an assembly of 1 mm, 0.250 mm and 0.053 mm sieves. After wet sieving and crushing of the aggregates on the 1 mm sieve, the materials from the 0.250 mm and 0.053 mm sieves were oven-dried at 50°C, weighed and ground, and measured for organic C content (Modified from Cambardella & Elliot, 1992)

Calculating and Data analysis

Method of calculating of carbon fractions from the soil

C stock (gm^{-2}) = C conc. in soil (%) x Bd ($g\ cm^{-3}$) x Soil depth (m) (Equation 1)

Where: C conc. in soil = volume of concentration of soil carbon

Bulk density ($g\ cm^{-3}$) = total density of soil at depth of 0-5, 5-10, 10-15 and 15-30 cm.

The data was analyzed for the effect of land use and soil depth on the amount of the various organic carbons, using the Two-way ANOVA by mean comparison with the least significant difference at a confidence level of 95%.

Results and Discussion

Soil management to amount of various organic carbon fraction

The average amount of the various organic carbons that can easily be dissolved, or are called labile organic carbon, in the soil samples collected at 0.30 cm depth on all ORF and CRF plots, showed that the amount of TOC, WSC and HWSC found in the ORF soil were significantly higher than in the CRF soil, at $p<0.05$. Additionally, the amounts of POXC, CPOM-C and FPOM-C in the CRF soil were higher than in the ORF soil, also at $p<0.05$ (see Table 1). Labile organic carbon constituted up to about 82% of TOC in the CRF soils, but constituted only about 35% of TOC in the ORF soils. All forms of labile organic carbon were higher in the CRF soils than in the ORF soils, with levels of CPOM-C > FPOM-C >> POXC >> HWSC > WSC. This sequence was found in both CRF and ORF soils (Table 2). CPOM-C is more easily mineralized than FPOM-C because FPOM-C is an organic carbon contained in fine soil particles and are protected from being mineralized by soil microbes. POXC is an organic carbon found in higher amounts than HWSC, and which might slowly react to soil management practices. Overall, our study also showed that the amount of labile organic carbon in the CRF soil samples was clearly higher than in the ORF soil samples.

Table 1 The mean amount of organic carbon fractions of soil organic carbon from CFR and ORF at 0-30 cm soil depth.

	Concentration					
Land use	TOC	CPOM-C	FPOM-C	POXC	HWSC	WSC
		($g\ kg^{-1}$)			($mg\ kg^{-1}$)	
CRF	25.50 B	18.24 A	17.44A	1.68 A	88.64 B	30.46 B
ORF	39.10 A	10.31 B	6.21B	1.21 B	108.41 A	44.00 A

Note: The difference of Upper Case latter that mean the treatments differ significantly ($P<0.05$)

TOC= Total organic carbon, CPOM-C= coarse particulate organic matter, FPOM-C = fine particulate organic matter, POXC = permanganate oxidizable carbon, HWSC= hot water soluble carbon, WSC = water soluble carbon

Table 2 The percentage detectable labile organic carbon fractions of total organic carbon from CFR and ORF at 0-30 cm soil depth.

			(% of TOC)				
Land use	CPOM-C	FPOM-C	POXC	HWSC	WSC	Total detectable Labile Carbon	missing carbon/ recalcitrant
CRF	40.16 A	37.96 A	3.69 A	0.21	0.05 B	82.07 A	17.93 B
ORF	22.16 B	10.09 B	2.45 B	0.21	0.11 A	35.01 B	64.34 A

Note: The difference of Upper Case latter that mean the treatments differ significantly (P <0.05)

TOC= Total organic carbon, CPOM-C= coarse particulate organic matter, FPOM-C = fine particulate organic matter, POXC = permanganate oxidizable carbon, HWSC= hot water soluble carbon, WSC = water soluble carbon

Storage of organic carbon in paddy soil

Our tests on the amount of organic carbon maintained in the soil in both ORF and CRF, at each soil depth of 0-5 cm, 5-10 cm, 10-15 cm and 15-30 cm, found that the maintenance of various organic carbon fractions was highest at 15-30 cm. We also found that, at the 0.30 cm depth level, the TOC in the ORF soil (15.44 kg m^{-2}) was higher than in the CRF soil (10.50 kg m^{-2}). Also, the organic carbon fractions maintained as recalcitrant organic carbon, such as CPOM-C, FPOM-C and POXC, were higher in the CRF soil than in the ORF soils, with a highly significant difference ($p<0.05$) (Table 3).

Table 3 Storage of organic carbon fractions in paddy soils under organic and conventional farming systems at 0-30 cm soil depth.

Land use	TOC	CPOM-C	FPOM-C	POXC	HWSC	WSC
		(kg m^{-2})			(g m^{-2})	
CRF	10.50 B	6.92 A	4.71 A	634.37 A	33.77	17.09
ORF	15.44 A	3.83 B	1.76 B	366.19 B	36.25	17.19

Note: The difference of Upper Case latter that mean the treatments differ significantly (P <0.05)

TOC= Total organic carbon, CPOM-C= coarse particulate organic matter, FPOM-C = fine particulate organic matter, POXC = permanganate oxidizable carbon, HWSC= hot water soluble carbon, WSC = water soluble carbon

Amounts of WSC and HWSC showed no statistically significant differences ($p>0.05$) in both types of paddy fields (Table 2) with fractions of CPOM-C>FPOM-C>>POXC>>HWSC>WSC. and if presented as percentage of total organic carbon fractions (% TOC), it was found that CRF soil had higher levels of every type of LOC than in the ORF soils excepted WSC (Table 2).

Soil property effect on C storage: CEC and Clay contents

Based on the analysis to determine CEC and clay contents in paddy soil under organic and chemical farming at a depth of 0.30 cm, it was found that CEC had equivalent values of 11.82 and 12.06 cmol kg^{-1}, ORF and CRF, respectively, which were not statistically different ($P>0.05$) but the clay contents of the OFR soils were higher than in CFR soils, at 36.62% and 16.63%, respectively, which were statistically different ($P<0.05$) (Table 4).

Table 4 Soil physical and chemical of CFR and ORF systems

Land use	Bd (g cm^{-1})	Clay %	Silt %	Soil Texture	CEC cmol kg^{-1}
CRF	1.25 A	16.63 B	19.97 B	sandy loam	12.06 A
ORF	1.25 A	36.62 A	40.00 A	silty clay loam	11.82 A

Note: The different Upper Case letters mean the treatments differ significantly ($P < 0.05$)

Soil management that affected the amount of various organic carbon and carbon storage

Surface retention of rice straw and stubble: From data gained from interviewing the farmers, it was found that the CRF farmers just left the crop residues in the field after harvesting the rice and taking them out of the field. The CRF farmers believed that the rice straw and stubbles should cover the soil. Management of these crop residues is considered an important method in accumulating organic carbon (Blanco-Canqui & Lal, 2007), although allowing the rice straw and stubbles to remain on the surface of the soil is a slower process than when the crop residues are plowed into the soil (Borresen, 1999). The amount of rice straw remaining in the planting area serves as a source of organic carbon, and affects the decomposition of SOM, as has been observed in this study, in both CRF and ORF soils. In either soil management approach, some amount of rice straw and other crop residues might be thrown away, but the amount returned to the soil planted with rice is greater in CRF soils than in ORF soils, thus making the amount of various labile organic carbon fractions higher in the ORF soils.

Therefore, the management of crop residues, particularly rice straw, allowed an appropriate amount of or recycle farmyard manure for fertilization and it was greatly needed as a labile organic carbon, SOM and soil minerals for bacterial organisms and small sized animals thus there was an effect towards the stability of fine soil particles because it would be able to maintain SOM too even if planted in chemical farming or organic farming.

Burning the stubble and straw of rice: When rice stubble and straw were burnt, soot, char and partly charred necromass were produced, which contained relatively inert macromolecular substances and greater quantities of aromatic mass (Baldock & Smernik, 2002), which is referred to as black carbon (Schmidt & Noack, 2000). In ORF, the use of char in the crop field enables the mineralization of organic nitrogen because it might cause N limitation while CRF could use the NPK fertilizer together with the use of char (the amount is higher than ORF) would be able to substitute for N that becomes limited.

Plowing for soil preparation and covering by rice rooted stubbles and straws: Plowing the soil and covering it with root stubbles and straws prepare the soil for planting during the dry season and onwards. When these are plowed and mixed with soil underneath and digested to finally dissolve, will finally become organic matter in the soil. At the same time, there is the formation of organic matter in the form of labile organic carbon as observed from soil planted with rice in both ORF and CRF but in the ORF, the rice straws are removed and use for other purposes as initially mentioned, leaving only the roots and stubbles in the soil after removing the harvested yield. But in both ORF and CRF soils, the roots of the rice plants are kept in the soil after harvesting the rice plants while the stubbles are plowed in the soil before planting time of soybean after 20 days. Plowing the soil that covers it with roots of the rice plants is an important to the amount of labile organic carbon such as dissolved organic matter (DOM). Thus plowing and covering the soil with rice stubbles and roots, could serve to increase the amount of DOM (such as WSC and HWSC) between ORF and CRF soils, which showed no significant difference in statistics. Aside from these, preparing the soil could allow the CPOM-C to decrease caused by the breakage of the soil particles thus the organic residues that are guarded from the bigger soil particles would be separated and would allow the microbes to digested them easily (Cambardella & Elliott, 1992; Mikha & Rice, 2004). Moreover, the incorporating the roots and stubbles of rice plants 30 days after preparing soil to the amount of CPOM-C and FPOM-C, showed that CPOM-C and FPOM-C were increased at about 0-1.2% when compared with that of not using the rice roots and stubbles and further stating that CPOM-C and FPOM-C, served as source of organic matter such as cellulose, hemicellulose, lignin and crude protein (Zhu et al., 2016). At the same time, on the organic carbon protected by the smaller soil particles (FPOM-C), the study showed a trend similar to CPOM-C. In the CRF soil, the amount of CPOM-C and FPOM-C was higher than in ORF soil. This might be due to the small soil particles became loose and formed to become larger soil particles (>0.25 mm) where organic carbon was easily digested (labile) as in parts of the rice crop such as straws and stubbles, roots, strips of fungus and substances that turned into soil microbes which function as substances that link together the small soil particles and become larger soil particles. Meanwhile, those larger and smaller soil particles work to guard those organic carbon materials too and the amount of CPOM-C and FPOM-C followed the same direction. From this study, it was found that ORF contained a more reduced amount of CPOM-C and FPOM-C than in CFR soil because the amount of remaining rice straws from plowing since farmers used them too for feeding animals, cultivate mushroom and produce compost fertilizer which are means of removing the crop residues from the system without returning them for its former use in the soil, thus making the amount of crop residues from rice cultivation by plowing them to be lower particularly the rice straws. But at the same time, the amount of DOM such as WSC and HWSC also increased, which may affect the amount of labile organic carbon in the long run and there is a need to consider together with other management practices together with the explanation of the organic and chemical rice production system where there is the dissolution of SOM in order for beneficial use in the soil and environmental quality management. Even though Slepetiene and Slepetys (2005) reported that plowing to prepare the soil as to promote the mineralization of organic carbon and used to reduce the amount of SOM of the soil, however, the fields used for cultivation where soil was plowed prior to cultivation for almost 40 years, was found to have an increased accumulation of humus as a result of the cropping system and of the use of organic fertilizer together with crop rotation and as a means to increase humus although that field is still used for conventional farming which involves soil management practices under both chemical and organic farming systems, though will increase the yield and also will preserve soil quality by plowing the rice roots to cover the soil, it is still of importance to the amount of SOM.

Effects of using chemical and organic fertilizer: The use of chemical fertilizer exerts effect by increasing the amount of organic carbon at a higher rate than without using fertilizer (Zhang, Zhu, Cai, Qin, & Müller, 2012). It can be seen that CRF soil where rice straw, stubbles and roots are thrown and which contain lignin that could be oxidized more in ORF and it could be possible that this POXC affects the amount of C that is accumulated more in the soil, where the maintenance of total organic carbon (TOC) in the soil was higher in ORF than in chemical farming with soil planted to rice contains rate of C accumulation at 0.53-4.98 kg $m^{-2}y^{-1}$ (Yan et al., 2013). And, Whalen, Hu, and Liu. (2003) reported that the crop residues (stubbles) of soybean that affect the low stabilization of soil particles as in corn because soybean contains lower phenolic content than corn residues which may affect the amount of CPOM-C and FPOM-C in terms of the guarding of C in the soil particles of both sizes, since the soil particles are more constant and SOC is increased allowing the soil particles to be more stabilized too. It might be said that the various labile organic carbon fractions in CRF soil are increased since they receive the impact from the management of mineral nutrients and water. It was found that the application of chemical fertilizer together with compost fertilizer or rice straw and stubbles together with holding of water continuously, can clearly be seen to increase the amount of total organic carbon in the soil. If consider the management between organic and chemical soils, it was found that the application of chemical fertilizer and/or organic fertilizer may affect the CPOM-C and FPOM-C, and POXC which is a labile organic carbon in CRF soil is much higher than in ORF. Aside from these, management of paddy field under chemical agriculture system still uses chemical fertilizer in order to increase the yield of the paddy field thus affecting the increased amount of POXC in soils under chemical agriculture system is higher than in organic soil. Therefore, the effect of different soil management of paddy field under two types of planting system would also affect the increased amount of CPOM-C and FPOM-C. The use of chemical fertilizer consecutively for 32 years by allowing the soil planted to corn to cause the amount of organic carbon to be accumulated increasingly to 22-30% when compared with soil that has not been applied with fertilizer that is increasing at 15-20% (John, Yamashita, Ludwig, & Flessa, 2005).Yan et al. (2013) reported that the use of a chemical fertilizer, NPK, together with organic fertilizer, caused the amount of CPOM-C and FPOM-C and the amount preserved by CPOM-C and FPOM-C to be increased in soil than in soil without fertilizer application. Also Aoyama, Angers, N'Dayegamiye, and Bissonnette. (1999), stated that the use of NPK fertilizer only consecutively for 18 years, could increase the amount of organic material in the part of being guarded by large soil particles particularly N at 2.5 times but that increase is not able to reach C. In summary, that chemical fertilizer promotes the maintenance of carbon and nitrogen by CPOM-C and FPOM-C with occluded with soil particles and occurs when there is application of chemical fertilizer in CRF soil. Meanwhile, the field plots applied with compost fertilizer for almost 140 years found an increased SOC in the exponential form and 3x value more when compared with field plots not applied with fertilizer, in which the use of fertilizer means the increase of SOC as reported by Haynes and Naidu (1998) who observed that the area applied with NPK fertilizer thus increasing the amount of SOC at 11% while areas applied with compost contain increased SOC at 30% when compared with areas not applied with fertilizer. From the report of Tirol-Padre and Ladha (2004), organic fertilizer was used for rice cultivation consecutively for 16 years causing the amount of TOC, POXC and ratio of POXC/TOC to increase in which the amount of LOC such as POXC might be guarded by macro-aggregates and macro-soil particles by physical mechanism such as holding in the structure of soil particles or absorbed on the surface of both types of soil such as lignin. In most particular, lignin which contains carbon that was oxidized as reported by Loginow, Wisniewski, Gonet, and Ciescinska. (1987) that lignin was oxidized by permanganese much better than cellulose because the molecular structure of lignin was formed from glycol groups and double bonds which can easily be oxidized in which that POXC process could oxidize C as a component of lignin that is guarded by a physical mechanism.

Effect of clay contents to storage of C fractions: It can be seen that CEC values of paddy soil of the two farming systems were not different which might be caused by the soil having stagnant water and field plots were near each other. But the soil in ORF system was more clayey than in the chemical farming system because organic materials and soil microbes played a significant role in soil formation, as reported by Six, Conant, Paul, and Paustian. (2002), that served as a mechanism to regulate the disintegration of organic materials by biochemical, chemical and physical methods respectively. The study on the relationship between clay contents and storage of C fractions showed that in the organic paddy soil, TOC was significantly related in statistics at 0.05 and when considering the level of relationship, it was found that there was direct correlation with CEC (r = 0.3510 and p= 0.00) and in CRF showed (r = 0.4106 and p= 0.000) but organic soil had higher content of organic matter. In CRF soils, a correlation was observed between FPOM-C and CEC with TOC having direct correlation with clay contents. This might be due to the intensive and continuous usage of paddy soil under chemical farming that led to FPOM-C containing much finer soil macro-aggregates (53-250 micrometer). These organic particulates would be more difficult to decomposed than larger organic particulates and had the potential as a source of carbon storage in the soil. Besides, soils with high volume of clay minerals could naturally affect the increase of organic matter in the soil resulting to the higher amount of total organic carbon storage in the soil.

Conclusion and Suggestion

The amount of organic carbon and the maintenance of carbon on the part of TOC in the paddy soil of ORF, was higher than in conventional farming system but the amounts of POXC, CPOM-C and FPOM-C in CRF soil was much higher than in ORF soil. This might be due perhaps on the management of rice stubbles remaining in the paddy field after harvesting of rice yield because more than 50% of ORF farmers used the crop residues outside of the field for other activities but the amount that was returned to the same field planted with rice was lower as when compared with CRF. This was in confirmation with the amount of POXC, CPOM-C and FPOM-C in CRF soil where the amount was higher because the amount of crop residues mentioned as being removed from the field was lower. For the maintenance of carbon (TOC) in ORF soil was much higher than in CRF soil perhaps as an effect of a mechanism resulting to the stabilization that occurred from the clay contents in the ORF soil, which was higher than in CRF soil and the process of mineralization of organic materials which was the function of LOC which came as involved. Thus the management of organic materials under the organic agriculture system may be necessary to be studied towards the management of organic matter to allow the capability to release mineral nutrients to increase the yield of the soil and greatly on its sustainable fertility while at the same time, allow the organic matter to have a role towards the environment depending on the mechanism of maintaining the carbon in the soil.

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