Cambios en carbono orgánico en suelos cambisoles, solonetz y arenosoles

Changes in organic carbon in cambisols, solonetz and arenosols soils

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Resumen

La llanura costera en el norte del estado de Nayarit tiene una extensión aproximada de 250 000 ha y en ella se encuentran áreas cultivadas con sorgo, maíz y frijol, que se han manejado durante años bajo esquemas de agricultura intensiva. Los suelos presentan síntomas de degradación, sobre todo en el contenido de materia orgánica, y alteraciones en las características morfológicas, por ello es importante determinar las pérdidas de carbono orgánico por la influencia de esta agricultura de altos insumos, en comparación con suelos de áreas conservadas de la llanura. Dicho trabajo fue realizado sobre paisajes geomorfológicos (llanura alta, media y baja) y en tres de los principales suelos presentes en el área de estudio (Cambisoles, Solonetz y Arenosoles). En Cambisoles las pérdidas de carbono orgánico en la llanura alta y media fueron de 36-40, 26-30 y 24-25 %, para las capas de 0-20, 0-50 y 0-100 cm; mientras que en la llanura baja fueron mayores. En los Solonetz se registraron pérdidas de

60, 55 y 50 % para estas mismas capas; mientras que en los Arenosoles las pérdidas fueron mayores, 92, 89 y 80 % para las capas estudiadas.

Palabras clave: suelos, degradación, Nayarit.

Abstract

The coastal plain in the North of the State of Nayarit has an extension has approximately 250, 000 ha and there are areas cultivated with sorghum, corn and beans, which have operated for years under intensive agriculture schemes. The soils have symptoms of degradation, especially in the content of organic matter, and alterations in the morphologic characteristics, so it is important to determine the losses of organic carbon by the influence of this high input agriculture, compared with soils of conserved areas of the plain. Such work was performed on geomorphological landscapes (plains high, medium and low) and three of the main soils in the area of study (Cambisols, Solonetz and Arenosols). Cambisols organic carbon on the high plain and average losses were 36-40, 26-30 and 24-25%, for layers from 0-20, 0-50 and 0-100 cm; While they were higher in the low plain. The Solonetz reported losses of 60, 55 and 50% for these same layers; While in the Arenosols losses were higher, 92, 89 and 80% for the studied layers.

Key words: soil degradation, Nayarit.

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Introduction

The loss of organic carbon in soils of ecosystems is an issue that has become important in the last 20 years, whether in relation to the concentration of atmospheric CO2 and climate change (Lal et al., 2007;) Varallayay, 1990), as with the problems of soil degradation (Hernández et al., 2006). There is evidence that the agricultural use and continuous tilling of the soil is the main cause of the decline of the organic matter (OM) in the plow layer with consequent degradation of their fertility (Roscoe & Buurman, 2003; Garcia-Silva et al., 2006). This decrease involves problems of degradation on the structure and soil compaction, increase in bulk density (Da) and decrease of porosity (Hernández et al., 2010 and 2013).

Therefore, one of the major problems faced by farmers working the soil is perhaps the gradual loss of organic matter from the soil (MOS) (Crovetto, 1996; Correlations et al., 2008). As a result of this situation, increasing soil dispersion factor, bulk density (Da) and compactness, decreases porosity and the active surface of the soil affects the action of roots in the intake of water and nutrients, as well as the biological activity, all this brings resulting increasingly lower yields.

In Nitisols ferralic rodicos soils of Cuba, has been observed in the impact produced agriculture continued for more than 50 years in physical properties, hydrophysical and biological (Morell & Hernandez, 2008;. Hernández et al, 2010; 2013). Soil degradation that increases the amount of work preparation of soil, fertilizer and other inputs. Thus, the current production model is becoming unsustainable year after year, resulting in decreased soil organic reserves and thus reduced potential yields in the short term (Manna et al., 2003).

The loss of organic carbon, as part of the MOS, not only related to the degradation that occurs in soil properties by the mineralization of OM in tropical soils, but also involved in the problem of climate change (Hernández et al ., 2006). In the last 30 years, ferralic Nitisols ródicos soils have increased in regions of low pH culture situation attributed to the combined action of soil degradation with increasing temperature (0.90 C) that has taken place in that region in the last 60 years (Morales et al., 2008).

This process of soil degradation caused by the influence of continued cultivation for many years, is also known as agrogénica evolution (Tonkonogov & Guerasimova, 2005; Dobrinova, 2009; Hernandez et al, 2013.). Because of this, in the classifications of soils worldwide trend is currently separated into the soil affected by the anthropogenic influence, as in the case of the American Soil Taxonomy (Soil Survey Staff, 2010) and WRB soil classification (IUSS, Working Group WRB, 2008).

Several authors have reported changes in soil organic carbon (SOC) (Murray et al, 2011, 2014.); in the case of COS Cambisoles differences attributable to differences in soil development are reported. The abatement of MO could be explained by soil management in the topsoil (0-20 cm), but its influence decreases with depth. In Arenosols low in organic matter and therefore they appreciate carbon because sue¬lo texture, tropical climate and dominant vegetation; the contribution of organic matter to the life cycle is reduced and sandy soil texture (poor in bases and in biológi¬ca activity), and the process of humification is scarce. Ade¬más in this tropical climate with annual rainfall of 1000-1200 mm, the washing of humic substances is intense, resulting in a low content of organic matter in the soil, which decreases rapidly mineraliza¬ción when driven under cultivation (Murray et al., 2014).

The soils of the coastal plain north of Nayarit have been studied from the point of view of their distribution, characteristics and classification as shown by the work of Bojorquez et al (2006 and 2007). From these studies it is known that the soils of this region have been subject to intensive cultivation for many years with plantings of sorghum, beans and corn primarily. These authors state that the distribution and characteristics of the Cambisols, Solonetz and Arenosols floors are depending on the geomorphological conditions of the plain (Bojorquez et al., 2006).

So far there are no identified reports or data on the change in the content of MO and organic carbon in these soils, although it is known that they are under a process of losing their natural fertility by man's influence because intensive agriculture which have been subjected. Therefore, in this paper we decided to perform the characterization of the content of organic carbon in Cambisols, Solonetz and Arenosols, both in areas under agricultural management, and conservation areas (relicts of tropical forest which serve as a standard), with the aim of generate information on the impacts of agricultural influence on the carbon content of soils in this region and thus provide basic elements for future work aimed at the capture and storage of this element.

MATERIALS AND METHODS

Study area

Pacific Coastal Plain is located northwest of the state of Nayarit, comprising 445 069 ha and represents the study area (Figure 1). Its origin is related to marine transgressions occurred during the Quaternary and started from late Pleistocene and Holocene and is from this moment that takes place a regressive behavior of the sea, a phenomenon that continues to this day (Gonzalez et al. , 2009). This has resulted in a diversity of landscapes that include deltas (floodplains), wetlands (mangroves, coastal lagoons and estuaries); coastal bars adjacent to the coast, which are constantly changing by processes geomorphological and pressure of farming, fishing, aquaculture, human settlements, besides recently tourism.

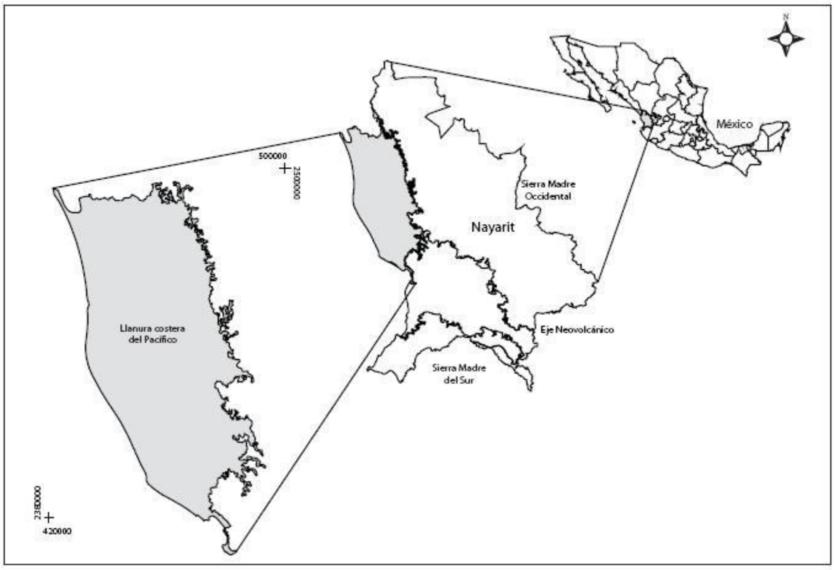

Figure 1. Location of the study area

The soils of this region are under the influence of a warm humid climate with summer rains, with ustic moisture regime. Water recharge them happens by rain (1000 to 1200 mm annual) and the flooding regime (sediments, nutrients and carbon) of different geomorphological levels that form the delta of the San Pedro River.

Materials and methods

For the development of this work 12 soil profiles (2009) representing the northern coastal plain were taken as pairs (cultivated and preserved) to a repetition (in 2011) in different geomorphological landscapes of the plain (Table 1, .. figure 2) separated by Bojorquez (et al, 2006) and Gonzalez (et al, 2009), identified as:

- High Plains dominated Cambisols without salts.
- Plain media presence of Cambisols, feozems, Solonetz and Fluvisols, some with salico qualifier.
- Plain floor where are represented Fluvisols, Cambisols and Stagnosols most salts.
- The marshes dominated Solonchaks.
- The system of coastal bars, dominated by Arenosols.

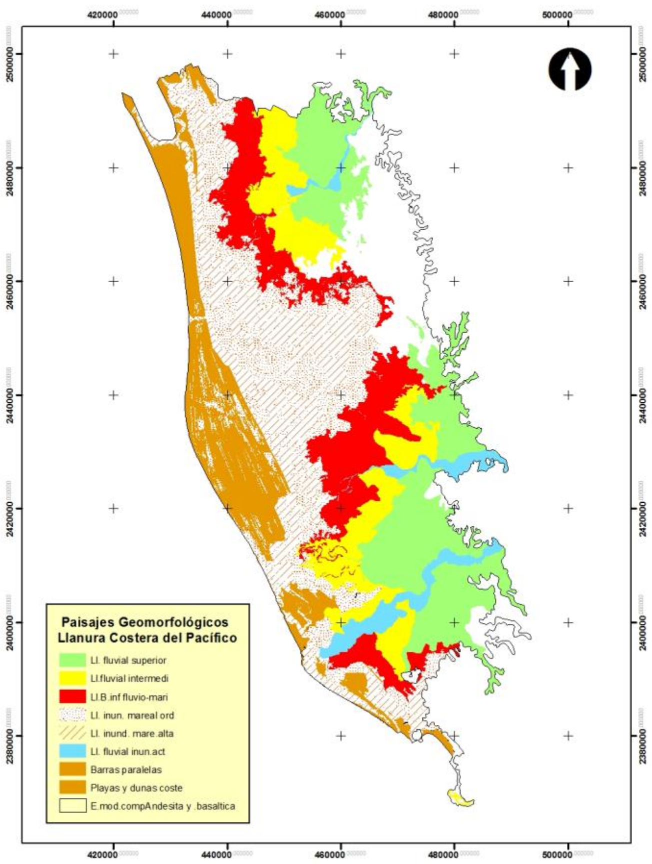

Figure 2. geomorphological landscapes Pacific Coastal Plain

Each soil profile was characterized by its physical and chemical properties from one sample for diagnostic horizon, which is classified based on the criteria of the World Reference Base (IUSS, Working Group WRB, 2008). The analysis of samples was to determine the content of organic matter (OM); pH (measured in water); cation exchange capacity (CEC), texture by the method of Bouyoucos; bulk density (Da) by the method of the cylinder; actual density (Dr), by pycnometer; total porosity (Pt) by the formula: Pt = (1- (Da / Dr) x 100); field capacity (CC) (Page et al., 1982); aeration porosity (Pa) by calculation from the total porosity (Pt), minus field capacity (CC). Organic carbon was estimated from the values of organic matter (OM / 1,724).

Table 1. Characteristics of the study sites and geographic location of the profiles studied in the coastal plain of Nayarit.

Paisaje geomorfológico	Perfil	Localización (Coordenadas métricas X-Y)	Clasificación del suelo	Uso del suelo
Llanura Alta	RM2	X 477182 - Y 2428633	Cambisol	Pastizal
	RM1	X 476824 –Y 2428760	Cambisol	Agrícola
Llanura Media	Tux-40	X 470755 - Y 2423488	Cambisol	Bosque de Palapar
	Tux-39	X 471785 - Y 2425392	Solonetz	Agrícola de riego
	Tux-37	X 468547 -Y 2422119	Cambisol	Bosque de Palapar
	Tux-38	X 465847 - Y 2425109	Solonetz	Pastizal
Llanura Baja	Tux-48	X 457370 - Y 2432833	Cambisol	Agrícola
	Tux-49	X 457381 -Y 2432810	Cambisol	Agrícola
	Ixc- 42	X 435066 - Y 2444017	Arenosol	Cultivo de coco
	Ixc-41	X 434609 - Y 2445274	Feozem	Palapar
	Ixc 45	X 433918 - Y 2431349	Arenosol	Vegetación herbácea
	Ixc-43	X 436134 - Y 2437610	Arenosol	Agrícola

The determination of the carbon was performed by applying the formula given by Murray (et al., 2014):

$$RC = (Eh)\ (Da)\ (\ \%\ de\ C)$$

Where:

RC = Carbon content expressed in Mg ha^{-1}

Eh = Horizon thickness (depth) in cm.

Da = Bulk density gcm^{-3}

% de C = Carbon percentage horizon

In each case, the Da is expressed in g cm-3 for layers 0-20, 0-50 and 0-100 cm, to serve as a systematic comparison with each repetition at a depth of 0-20 cm per sample experimental compound; coincides with the thickness of soil horizon which in turn coincides with work by Murray et al (2011 and 2014).

A completely randomized experimental design was used with two replications and data were analyzed using ANOVA standard procedure for a statistical design with two repetitions, with the MO and Da variables. Correlation and means comparison $p < 0.05$ was made. SAS software was used in the analysis of variance and to detect statistical differences between treatments the Tukey test was performed.

Results and discussion

High Plains

Cambisols present in this landscape are different in carbon stocks due to the use to which they have been subjected. The profile has preserved pasture, for the layer of 0-20 cm, a difference of 15 Mg ha-1, when compared with the cultivated (Table 2). These data show losses close to 36, 26 and 24% carbon, for layers 0-20, 0-50 and 0-100 cm respectively, relating to the preserved cultivated soil in humid tropical climate conditions, which coincided with the results obtained by Roscoe y Buurman (2003) y Martínez-Trinidad (*et al.*,2008).

Half plain

This landscape has two subpaisajes: half plain and depression surfaces which four soil profiles were taken, two for each subpaisaje and for each condition of use (soils Cambisols; profiles TUX TUX-40 enpalapar and-39 on growing areas irrigated sorghum) and two surfaces of depression within the same (soil Solonetz; profiles TUX-37 in palapar and TUX-38 and now cultivated pastures).

Table 2. Content in carbon stocks in the high plains Cambisols.

No. Perfil	Eh Prof. cm	C %	Da g cm^{-3}	RC Kg ha^{-1}	C* %	Da* g cm^{-3}	RC* Kg ha^{-1}
RM-1	0 – 20	0.98	1.33	26.1	1.02	1.36	26.5
(Cultivado)	20 -45	0.94	1.39	32.7	0.99	1.35	33.4
	45 – 55	0.91	1.51	13.7	0.90	1.50	13.5
	55 – 85	0.81	1.39	33.8	0.84	1.40	35.2
	85 - 110	0.80	1.30	26.0	0.81	1.38	26.5
RM-2	0 – 5	1.93	1.21	11.7	1.98	1.19	11.8
(Conservado)	5 – 25	1.56	1.24	38.7	1.55	1.24	38.5
	25 – 70	1.13	1.37	69.7	1.16	1.37	71.5
	70–100	1.47	1.07	47.2	1.50	1.07	48.1

Eh=profundidad, C=carbono, Da=densidad aparente, RC= reserva de carbono, repetición. *

Table 3 shows the data of some properties of these soils and organic carbon are presented. In the case of Cambisols soil, the soil must be low palapar has a higher organic carbon content of the soil cultivated. The increase in COS accumulated between 2009 and 2011 is attributed to two factors: a higher percentage of C and a lower value of the bulk density. Basaran et al. (2008) found, with different land uses that Da decreased in places where the COS was high. The value of carbon losses is 40%, 30% and 25% for layers 0-20, 0-50 and 0-100 cm respectively, which coincide with those reported by Roscoe and Buurman (2003), who mentioned losses between 30 and 50% of the soil organic carbon (SOC) in the topsoil, over a period of over 40 years of cultivation.

Table 3. Content of organic carbon in the middle plain Cambisols.

No. Perfil	Eh Prof. cm	C %	Da g cm^{-3}	RC Kg ha^{-1}	C* %	Dv* g cm^{-3}	RC* Kg ha^{-1}
TUX-40	0 – 12	3.22	0.90	34.8	3.23	0.90	34.9
(Conservado en	12 – 30	2.49	0.94	42.1	2.65	0.92	43.8
palapar)	30 – 45	1.87	1.19	33.3	1.98	1.12	33.3
	45 – 92	1.27	1.22	72.8	1.28	1.25	74.4
	92-110	1.15	1.37	28.4	1.17	1.30	27.4
TUX-39	0 – 27	1.33	1.21	43.5	1.22	1.20	39.5
(Cultivado)	27 – 50	1.19	1.39	38.0	1.14	1.48	36.7
	50 – 72	1.05	1.19	27.5	1.05	1.22	28.1
	72 - 105	1.08	1.27	45.3	1.06	1.30	45.4
TUX-37	0 – 17	3.25	0.94	51.9	3.25	0.95	52.4
(Conservado en	17 – 40	1.80	0.97	40.2	1.80	0.97	40.2
palapar)	40 – 63	1.31	1.19	35.9	1.33	1.18	36.0
	63 – 81	1.28	1.27	29.3	1.28	1.25	28.8
	81-110	0.55	1.30	20.7	0.58	1.27	21.3
TUX-38	0 – 5	3.06	1.02	15.6	2.92	1.10	16.0
(Cultivado antes,	5 – 20	0.75	1.08	12.2	0.76	1.22	13.4
ahora en pastizal)	20 – 30	0.62	1.25	7.8	0,98	1,30	12.8
	30 – 45	0.45	1.34	9.0	0,46	1,32	9,18
	45 – 95	0.64	1.17	37.4	0,64	1,20	38.4
	95 - 120	0.63	1.10	17.3	0,63	1,20	18.0

Eh=profundidad, C=carbono, Da=densidad aparente, RC= reserva de carbono, repetición. *

In depressions, in this part of the plain soil Solonetz presence, comparing the values of soil carbon stocks under palapar (TUX-profile 37) with cultivated (TUX-profile 38), losses are observed 60%, 55% and 50% for layers 0-20, 0-50 and 0-100 cm respectively, these results are similar to those found by Bayer et al., (2002). In both cases higher losses are evident in the 0-20 cm layer due to anthropogenic influence is greater in the arable soil layer.

lower down

In this landscape two profiles were studied in the region called La Horqueta (profiles TUX TUX-48 and A-49), and the soils proved Cambisols. Table 4 shows the data of their carbon stocks are presented.

Table 4. Content of organic carbon in the low plain Cambisols

No. Perfil	Eh Prof. cm	C %	Dv g cm^{-3}	RC Kg ha^{-1}	C* %	Dv* g cm^{-3}	RC* Kg ha^{-1}
TUX-48	0-10	0.51	1.09	5.6	0.50	1.32	5.6
(Cultivado)	10-24	0.42	1.26	7.4	0.41	1.34	7.4
	24-32	0.42	1.34	4.5	0.39	1.35	4.5
	32-43	0.24	1.24	3.3	0.25	1.24	3.3
	43-53	0.24	1.35	3.2	0.23	1.35	3.2
	53-65	0.24	1.04	3.1	0.23	1.04	3.1
	65-85	0.27	1.10	5.9	0.26	1.10	5.9
	85-100	0.32	1.10	5.3	0.31	1.10	5.3
TUX-49	0-15	1,52	1.31	29.9	1.57	1.10	26.6
(Conservado)	15-30	1.46	1.11	10,0	1.44	1.12	24.3
	30-42	0.51	0.99	6.1	0.71	0.98	8.2
	42-50	0.34	0.94	2.6	0.34	1.00	2.7
	50-60	0.08	0.95	0.8	0.48	0.92	4.4
	60-81	0.08	0.81	1.4	0.48	0.81	8.1
	81-100	0.34	0.95	6.1	0.41	0.95	7.4

Eh=profundidad, C=carbono, Da=densidad aparente, RC= reserva de carbono, repetición. *

When the profile preserved cultivated with a decrease of the carbon content which is differentiated for the different layers was observed. Cultivated profile there is a decrease in carbon content of 67%, 50% and 33% for layers 0-20, 0-50 and 0-100 cm respectively. On the one hand it is evident that higher agricultural layer turns out to be the most affected as a result of the continued farming with agrochemicals and intensive use of machinery, without applying any organic improvement to the ground, and on the other, it turns out that this affected the lower layers decreases, especially 50-100 cm layer of soil. On the latter one you can assume that it is necessary primarily to improve the first 20 cm of topsoil.

Carbon losses in Cambisols of this landscape are in accordance with the criteria Lalet al., (2007), who argue that the losses in soils of different ecosystems ranging between 30% and 75%. You can also compare these results to those obtained by Hernandez et al., (2009), who found in soils Nitisols ferralic (eutric, ródicos) grown carbon losses of 59%, 36% and 33% (for layers of 0- 20, 0-50 and 0-100 cm respectively) against soils under trees many years having carbon stocks of 67, 97 and 133 g cm-3, for these same layers. In contrast, Ojeda et al., (2009) found an increase in carbon (2970 kg ha-1) in a savanna grasses cultivated for four years, compared to the natural savanna.

In the case of offshore bars, where the parallel bars are formed with a soil mesocombinación Arenosols and Solonchaks (Bojórquez et al., 2007), several profiles were studied in different Arenosols subpaisajes. In the middle bar with seasonal flooding in the rainy season, the IXC-41 profile was taken, under a palapar, while in non-flooding high bars, 3 profiles (IXC- 45, in the beach bar were studied IXC-42 coconut cultivated and grown IXC-43).

Table 5 shows the results of the carbon to the soils are presented. It is appreciated that Arenosols have very low content of organic matter and hence carbon, even in the profile taken under vegetation palapar due to soil texture, tropical climate and type of palapar with scarce vegetation between the palms. That is, the contribution of vegetation to the biological cycle is reduced and soil with sandy texture (poor bases and biological activity), the process of humification is scarce; Moreover, in this tropical climate with annual rainfall of 1000-1200 mm, the washing of humic substances is intense, resulting in a low content of organic matter in the soil, which decreases rapidly when the soil mineralization Arenosol handled under cultivation.

Table 5. Content of organic carbon in the low plain Arenosols

No. Perfil	Eh Prof. cm	C %	Dv g cm^{-3}	RC Kg ha^{-1}	C* %	Dv* g cm^{-3}	RC* Kg ha^{-1}
IXC-45	0-15	0.12	1.63	2.93	0.12	1.63	2.93
Playa, con escasa	15-45	0.12	1.60	5,76	0.12	1.61	5.79
vegetación	45-100	0.04	1.64	3.61	0.04	1.64	4.18
IXC-42	0-5	0.03	1.43	0.21	0.04	1.44	0.28
Cultivado con	5-35	0.03	1.36	1.22	0.03	1.35	1.21
árboles de coco	35-60	0.03	1.26	0.95	0.03	1.30	0.97
	60-85	0.03	1.46	1.00	0.03	1.47	1.10
	85-100	0.02	1.45	0.44	0.02	1.45	0.43
IXC-43	0-23	0.03	1.60	1.10	0.03	1.61	1.11
Cultivado	23-45	0.03	1.56	1.03	0.03	1.56	1.03
	45-68	0.03	1.62	1.12	0.03	1.61	1.11
	68-100	0.03	1.57	1.51	0.03	1.56	1.49
IXC-41 Palapar	0-25	0,45	1.20	13.5	0,46	1.18	13.6
	25-43	0,32	1.13	6.51	0,34	1.11	6.79
	43-64	0.03	1.21	0.76	0.05	1.32	1.05
	64-100	0.03	1.62	1.75	0.04	1.59	2.28

Eh=profundidad, C=carbono, Da=densidad aparente, RC= reserva de carbono, repetición.*

To Ladd et al, (1985).; Amato and Ladd (1992) and Skjemstad et al., (1993), sandy soils exhibit rapid mineralization of organic matter compared to clay soils. Therefore, it appears that the ground pattern (preserved) under palapar, the organic matter content is only 1.20%, and soils grown much lower (Table 5).

As for carbon losses from soil pattern (retained) losses and cultivated beach profile 64, 55 and 45% for layers 0-20, 0-50 and 0-100 cm respectively are observed, while for cultivated soil profiles ranges from 92%, 8% and 80% for layers 0-20, 0-50 and 0-100 cm. Moreover, carbon losses in the different landscapes of the delta plain keep the following behavior: in the upper plains losses are 36%; for plain average is 40%; for depression surfaces in the middle plain 60% to 67% lower plain and bars around 90%. This demonstrates that intensive farming has continued and caused losses in the carbon content. In general, when comparing the condition in different landscapes, losses are greater in the low plain, which may be related to increased agricultural influence and a regime of higher than average and high plain (Table 6) flood.

These impacts on soil properties are significant in the structure, the spreading factor, compaction, total porosity and biological activity. It was observed that in these soils is formed by the continuous cultivation, a structure for the first 20 cm block become of considerable size (20 cm or more) and this in land preparation is necessary to use machinery, and often running surface blocks. In these blocks the pores are filled with silt and clay particles that are vacated by the destruction of aggregates of the original structure, becoming larger and worse therefore soil properties.

Table 6. Content of organic carbon in geomorphological landscapes of the coastal plain (Kg ha^{-1}).

Paisaje Geomorfológico	No. Perfil	Espesor del horizonte o Profundidad (cm)		
		0-20	0-50	0 -100
Llanura Alta	RM-1	26.1	65.7	121.9
	(Cultivado)	26.5*	66.6*	124.6*
	RM-2	40.7	89.1	167.3
	(Conservado)	40.6*	90.2*	169.9*
	TUX-40	53.5	117.9	195.6
	(Conservado en palapar)	53.5*	119.0*	197.7*
	TUX-39	32.2	81.5	147.4
	(Cultivado)	29.3*	76.2*	142.9*
Llanura Media				
	TUX-37	67.1	107.7	170.9
	(Conservado en palapar)	67.6*	107.9*	171.0*
	TUX-38	27.8	53.3	90.4
	(Cultivado antes, ahora en pastizal)	29.9*	55.7*	93.9*
	TUX-48	10.9	24.1	38.3
	(Cultivado)	12.0*	24.0*	39.1*
	TUX-49	34.7	61.6	81.5
	(Conservado)	33.4*	60.5*	80.6*
Llanura Baja				
	IXC-45	3.89	9.09	12.30
	Playa, con escasa vegetación	3.89*	9.10*	12.9*
	IXC-42	0.82	2.00	3.82
	Cultivado con árboles de coco	0.86*	2.07*	3.99*
	IXC-43	0.96	2.38	4.80
	Cultivado	0.96*	2.38*	4.74*
	IXC-41 Palapar	10.8	20.3	22.5
		10.8*	20.7*	23.7*

COS=carbono orgánico del suelo, repetición. *

This makes it necessary to reorient and modify the technological models of production, where the use of amendments, organic soil improvers, bio-fertilizers and especially mycorrhizae are included to help increase the area of action of the plants with the ground, through the network of hyphae develop these fungi in the soil, and thus greater absorption of nutrients and moisture to the plants. In the end, it improves soil fertility, more leaf development by plants and therefore increase carbon sequestration. It should be noted that in addition to serving the agricultural production problem has occurred, improving the carbon content in soils contributes to reducing the concentration of CO_2 in the atmosphere and thus mitigates the effects of climate change that is occurring today day.

Conclusions

Comparing the values obtained under different soil management systems (cultivated and preserved), show a loss of organic matter and, therefore, of organic carbon in the high plains were approximately 36%; in the middle plain 40% and the low plain of 67%.

Parallel bars there were losses of 90%, an increase in bulk density, confirming a correlation matter organic-bulk density which results in loss or reduction in the floor structure in the first 20 cm, and granular structural changes to blocks, a situation which, combined with the climatic conditions of the region favors washing humic substances, resulting in a low content of organic matter in soils, whereas in Arenosols under cultivation, can decrease rapidly mineralization . Therefore, it is not advisable to cultivate therefore exhibit rapid mineralization of organic matter in comparison with clay soils.

Bibliography

Ojeda, D.A., M. Stein & D. López-Hernández (2009). Secuestro de carbono orgánico y cambios de fertilidad en un Ultisol de sabanas en la Amazonía Venezolana. Bioagro 21(3): pp. 195-202.

Amato, M., & J.N. Ladd (1992). Decomposition of 14C-labelled glucose and legume material in soils: properties influencing the accumulation of organic residue C and microbial biomass C. Soil Biol. Biochem., 24: pp. 455-464.

Basaras, M., G. Erpul, A. E. Tercan & M.R. Canga (2008). The effects of land use changes on some soil properties in Indagi Mountain Pass_Cankiri, Turkey Environ. Monitoring and assessment 136: pp. 101-119.

Bayer, C., M. Neto, L. Mielniczuk, C. Pillon & L. Sangoi (2001). Changes in Soil Organic Matter Fractions under subtropical No-Till Cropping systems. Soil Sci. Soc. Am. J. 65:pp. 1473-1478.

Bojórquez, I., A. Hernández, D. García, O. Nájera, F. Flores, A. Madueño & R. Bugarín (2007). Características de los suelos Cambisoles y Fluvisoles de la llanura costera norte del estado de Nayarit, México. Cultivos Tropicales 28(1):pp. 19-24.

Bojórquez, I., O. Nájera, D. García, A. Hernández, A. Madueño, R. Bugarín (2006). Formación de suelos y principales suelos de la llanura costera norte de Nayarit, México. Cultivos Tropicales 26(4): pp. 34-45.

Crovetto, C. (1996). Stubble over the soil. The vital role of the plant residue in soil management to improve soil quality. Special Publication 19. American Society of Agronomy. Madison, Wisconsin, USA.

Dubrovina, I. (1999). An experience of a large scale soil mappingwith the use of a new Russian Soil Classification system. Abstracts International conference «SoilGeography: New Horizons». Huatulco, Oaxaca, México.

García-Silva, R., D. Espinosa-Victoria, B. Figueroa-Sandoval, N.E. García-Calderón & J.F. Gallardo-Lancho (2006). Reservas de carbono orgánico y de fracciones húmicas en un Vertisol sometido a siembra directa. Terra Latinoamericana 24: pp. 241-251.

González, A., I. Bojórquez, O. Nájera, D. García, A. Madueño & F. Flores (2009). Regionalización ecológica de la llanura costera norte de Nayarit, México. Vol. 69: pp. 21-32.

Hernández, A., M. Ascanio, M. Morales, F. Morell & Y. Borges (2006). Cambios globales en los suelos Ferralíticos Rojos Lixiviados (Nitisol ferrálicos, éutricos, ródicos) de la llanura roja de La Habana. Cultivos Tropicales 24(2): pp. 41-55.

Hernández, A., M. Morales, F. Morell y Borges, D. Vargas, F. Funes, F. Monzote, F. Marentes & H. Ríos (2009). La formación agrogénica en los suelos ferralíticos rojos lixiviados (Nitisoles ferrálicos, éutricos, ródicos) de provincia La Habana. Universidad Agraria de la Habana (UNAH), Cuba.

Hernández, A., J.I. Bojórquez Serrano, F. Morell Planes, A. Cabrera Rodríguez, Miguel O. Ascanio García, Juan Diego García Paredes, A. Madueño Molina & O. Nájera González (2010). Fundamentos de la estructura de suelos tropicales. Publicado en formato digital por la Universidad Autónoma de Nayarit, México. ISBN: 978-607-7668-27-9. 80 p.

Hernández Jiménez, Alberto, Marisol Morales Díaz, Adriano Cabrera Rodríguez, Miguel O Ascanio García, Yenia Borges Benítez, Dania Vargas Blandino & Andy Bernal Fundora (2013). Degradación de los suelos Ferralíticos Rojos Lixiviados y sus indicadores de la Llanura Roja de La Habana. Cultivos Tropicales, Vol. 34, No. 3, pp. 45-51.

IIUSS, Working Group, WRB, 2008. Base referencial mundial del recurso suelo. Informes sobre recursos mundiales de suelos 103. FAO, ISRIC, 117 pp.

Ladd, J.N., R.C. Foster & J.O. Skjemstad (1985). Soil structure: Carbon and nitrogen metabolism. Geoderma 56: pp. 401-434.

Lal, R., R. Follet, B.A. Stewart & J.M.Kimble (2007). Soil carbon sequestration to mitigate climate change and advance food security. Soil Science, Vol. 172, No. 12, pp. 943-956.

Manna, M.C., P.K. Ghoshy C.L. Acharya (2003). Sustainable crop production through management of soil organic carbon in semiarid and tropical India. J. Sustainable Agric. 21: pp. 87-116.

Martínez-Trinidad, S., H. Cotler, J.D. Etchevers-Barra, V.M. Ordaz-Chaparro y F. de León-González (2008). Efecto del manejo en la agregación del suelo en un ecosistema tropical seco. Terra Latinoamericana 26: pp. 299-307.

Morales, M., A. Hernández, F. Marentes, F. Funez-Monzote y Borges, F. Morell, D. Vargas & H. Ríos (2008). Nuevos aportes sobre el efecto de la disminución de materia orgánica en los suelos Ferralíticos Rojos Lixiviados. RevistaAgrotecnia de Cuba, vol. 32, pp. 57-64.

Morell, P. F. & H.A. Jiménez (2008). Degradación de las propiedades agrobiológicas de los suelos Ferralíticos rojos lixiviados por la influencia antrópica y su respuesta agroproductiva al mejoramiento. Agron. Trop. 58:pp. 335-343.

Murray-Núñez, R. M., J. Bojórquez, A. J. Hernández, M.G. Orozco, J.D. García, H.G. Ontiveros & J. Aguirre (2011). Efecto de la materia orgánica sobre las propiedades físicas del suelo en un sistema agroforestal de la llanura costera norte de Nayarit, México. Revista Bio Ciencias, vol. 1, no. 3, año 2, pp. 27- 35. ISNN 2007-3380.

Murray, R. M., M. G.Orozco, A. Hernández, C. Lemus, O Nájera (2014). El sistema agroforestal modifica el contenido de materia orgánica y las propiedades físicas del suelo 1 Avances en Investigación Agropecuaria. 8(1): 23-31. Issn 0188789-0

Roscoe, R.,y P.Buurman (2003). Tillage effects on soil organic matter in density fractions of a Cerrado Oxisol. Soil Tillage Res. 70: pp. 107-119.

Skjemstad, J.O., L.J. Janik, M.J. Head, S.G. McLure (1993). High energy ultraviolet photo-oxidation: a novel technique for studying physically protected organic matter in clay and silt-sized aggregates. J. of Soil Sci. 44:pp. 485-499.

Soil Survey Staff, 2010. Keys to Soil Taxonomy. USDA, undécima edición, 365 pp.

Tonkonogov, V., M. Guerasimova (2005). Agrogenic pedogenesis and soil evolution. Abstract International Conference "Global Soil Change", Mexico City, March 10-18, pp. 79-80.

Varallayay, G. (1990). Types of soil processes and changes. In Global Soil Change Int. Inst. for Applied System Analysis, Laxemburg, Austria, pp. 41-62.