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The effect of long-term cassava cultivation on organic carbon content and soil physical properties in Central Lampung

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SUMMARY

The effect of long-term cassava cultivation on organic carbon content and soil physical properties in Central Lampung has been investigated. A plot of land that had been cultivated for Cassava plants and another plot for mixed garden for more than 30 years were studied in order to know how the effect of of long-term cassava cultivation on organic carbon content and soil physical properties. The results show that long-term cultivation of cassava had reduced the thickness of the surface layer and organic carbon content, changed soil color become lighter and changed the shape of soil structure in the soil surface layer from crumbs become angular blocky. There was a tendency that the bulk density and the soil strength in cassava cultivation were lower in the surface layer and higher in the bottom layer.

Introduction

Cassava *(Manihot escu/enta* Crantz) *(Manihot escu/enta* Crantz) is an important agricultural commodity for Lampung Province. In 2015, Lampung Province had contributed 34% of national cassava production (BPS, 2015). Cassava could performs best in soils of friable nature to permit expansion of tubers (Nnaji, 2009), however, it is very tolerant of various soil conditions even in marginal soils which for other food crops are difficult to grow properly

Cassava is usually grown by farmers in the tropics with a minimum of inputs, and continuous production under these conditions can lead to soil nutrient depletion. On sloping land, cassava cultivation can also cause severe erosion if the crop is not properly managed (Howeler, 1991). Cassava is increasingly attractive as an energy crop due to its high rate of CO_2 fixation, high water-use efficiency, high carbohydrate content, and superior starch conversion ratio for ethanol compared to other crops (Kristensen *et al*., 2014).

Many people are convinced that cassava production leads to soil degradation, and some governments do not encourage cassava cultivation in the belief that it causes serious erosion and nutrient depletion (FAO, 2014).Cassava is grown throughout the tropics on a great variety of soils, but is mainly found on Ultisols, Oxisols and Entisols, which are generally characterized by low soil fertility. In many parts of the tropics it is grown on the poorest soils, such as on eroded slopes or extremely sandy soils, where it produces something whereas other crops would not. This ability has led many to think that cassava does not require high soil fertility nor responds to fertilization (Howeler, 1991).

This study aims to determine the effect of long-term (> 20 years) cassava cultivation on organic carbon content and soil physical properties compared to mixed garden in Central Lampung.

Materials and Method

This research was conducted on land that had been cultivated with cassava plants for 30 years in the Central Lampung, Sumatra. For comparison, a land that was planted with various trees on coffee base was chosen, and this land system was called mixed garden (MG). Both types of land use have the same land characteristics such as slope (3-4% gentle slope), acid tuffs parent materials (Mangga et al., 1994)), altitude (53 m asl) climate (2205.48 mm rainfall per year), and adjacent locations of around 60 meters.

Each plot of land has an area of about 1 hectare, with a rectangular shape stretching north to south. On each plot of land, three mini profiles are determined and made at the top of the slope, the middle of the slope and at the bottom of the slope. The soil profiles were described according to the Manual Survey Soil (1993) and then the soil samples were taken in the middle of soil layers, both

undisturbed soil samples using sample rings and disturbed soil samples. Soil Strength of each soil layer was determined in the fields by using Pocket Penetrometer. Soil samples analyzed include organic carbon (Walkley and Black), soil texture (Bouyoucos), bulk density. Then data of three profiles were averaged.

Result and Discussion

3. 1 Soil Morphology and Texture

After more than 30 years of cassava cultivation (C), it was seen that there were differences in surface layer thickness, soil color, and soil structure shape and soil organic matter content (Table 1). Accumulation of litter from dead leaves and then decomposition has led to higher organic carbon content in mixed garden (MG) . Meanwhile on cassava cultivation land which is rarely applied by organic matter and crop residues not returned to the land has caused lower organic carbon content. In addition, the more open land from the beginning of post-harvest, tillage, the beginning of planting until the next 3 months makes conditions conducive to the ongoing process of oxidation of soil organic matter and erosion. As a result, the thickness of the surface layer on cassava cultivation land is reduced.

The amount of soil organic matter is very influential on the color of the soil, making the color of the soil darker, this is indicated by the color of the soil on darker natural veg land (lower value and chroma) compared to cassava cultivation. Reduced soil organic matter on cassava cultivation has caused changes in the shape of the soil structure from crumbs to angular blocky. Another possibility that can change the shape of the structure in the surface layer is the loss of the surface layer so that the existing surface layer is actually the lower horizon that appears on the surface.

The consistency of soil is strongly influenced by the shape and size of the particles (Baver, 1956) and the type of clay minerals. Because the soil texture on both types of land is not much different (Table 2) and is predicted to have the same type of clay minerals, the consistency of the soil of the two types of land is the same, which is friable in the surface layer and firm in the lower layers (Table 1).

Bulk density in both types of land is not much different (Table 2). On cultivated land for cassava plants, soils is always ploughed before planting so that the soil surface layer is more nested (lower bulk density). Therefore, even though the content of organic matter in cassava cultivation land is lower than natural vegetated land, it has a slightly lower bulk density value. This is supported by the value of the soil strength which is also slightly lower. On the second layer, the opposite happened that bulk density on cassava cultivation land was slightly higher than mixed garden land, this was supported by the soil strength value and also its higher clay content. The higher content of clay in the lower layers of cassava fields is related to the higher leaching processes of clays due to the opening of the canopy.

Table 1. Soil Morphology

Land Use	*Layer*	*Layer Thickness*	*Color*	*Stru*	*Cons*	*C-org*
		cm				%
C	I	9	10 YR 3/3-3/4	ab	fr	1.54
	II	17	10 YR 5/6-5/8	ab	fi	0.85
MG	I	17	10 YR 2/2	cr	fr	3.09
	II	16	10 YR 4/4-4/6	ab	fi	1.21

*)Stru: Structure: ab (angular blocky),cr:crumb

**)Cons: Consistency: fr:friable; fi:firm

Table 2. Soil Physical Properties

Land use	*Hor*	*%*			*Bulk Density*	*Soil Strength*
		sand	silt	clay	g/cm3	kgf/cm^2
C	A	29.3	11.7	59.0	1.16	0.91
	B	18.9	9.5	71.6	1.22	3.09
MG	A	33.2	17.6	49.2	1.22	0.93
	B	21.6	12.2	66.2	1.16	2.89

Conclusion

Long-term cultivation of cassava results in reduced thickness of the surface layer and organic carbon content, the lighter color of the soil, and changes in the shape of

the soil structure in the soil surface layer from crumbs to angular blocky.

Although it is not much different, but there is a tendency that the bulk density and the soil strength in cassava cultivation land are lower in the surface layer and higher in the bottom layer.

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