Soil quality and crop health indicators in agroecosystems of the agricultural center HortCanaã, Paço do Lumiar, MA, Brazil

Indicadores de qualidade do solo e sanidade de culturas em agroecossistemas do polo agrícola HortCanaã, Paço do Lumiar, MA, Brasil

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Abstract

Sustainable production of agroecosystems can be monitored through indicators. The objective was to evaluate agroecological production systems at the HortCanaã agricultural center, Paço do Lumiar, MA, through indicators of soil quality and crop health. Areas of polyculture and monoculture were evaluated through the system of rapid method to estimate soil quality and crop health. The indicators presence of animals, soil conservation and state of residues presented high values of sustainability, which is related to the practice of local farmers to add organic residues in the cassava crop. There was low diversity of natural and surrounding vegetation and deficiencies in the structure of soils. Ecological practices such as green manuring and restoration of the surrounding native vegetation are suggested to provide environmental sustainability for the agroecosystems and to concretize the agroecological transition in the agricultural center of Maranhão.

Keywords: sustainability; Agroecology; cassava crop; polyculture.

Resumo

A produção sustentável dos agroecossistemas pode ser monitorada através de indicadores. Objetivou-se avaliar sistemas de produção agroecológicos no polo agrícola HortCanaã, Paço do Lumiar, MA, através de indicadores de sanidade dos cultivos e qualidade do solo. Foram avaliadas áreas de policultivo e monocultivo através do sistema de avaliação rápida da qualidade do solo e sanidade dos cultivos. Os indicadores presença de animais, solo conservado e estado de decomposição apresentaram valores elevados, o que está relacionado à prática dos agricultores locais de adicionar resíduos orgânicos na cultura de mandioca. Foi constatada baixa diversidade de vegetação natural e circundante e deficiências na estrutura dos solos. São sugeridas práticas ecológicas, tais como a adubação verde e restauração da vegetação nativa circundante para proporcionar sustentabilidade ambiental para os agroecossistemas e concretizar a transição agroecológica no polo agrícola maranhense.

Palavras-chave: sustentabilidade; Agroecologia; mandiocultura; policultivo.

Introduction

The productivity of conventional agriculture, most of the time, is accompanied by the degradation of environmental resources, for example groundwater pollution from agrochemicals and soil erosion. Thus, agroecological models that optimize nutrient cycling, reduce the use of external inputs and promote soil conservation and biodiversity are necessary to maintain a high and sustainable level of productivity (ALTIERI, 2012).

The sustainable production of agroecosystems can be characterized and monitored through indicators present in the soil and cultivated crops. This evaluation becomes efficient in evidencing weak and strong points that affect crop and soil health (FERNANDES et al., 2009). In addition, the quantification and interpretation of the effects of the indicators should be facilitated, since it guarantees the application of actions that make practicable culture management and the use of them by family farmers (LIEBIG; DORAN, 1999; FERNANDES et al., 2009). This is extremely important in Brazil, since family farming accounts for about 70% of the production of food consumed in the country (BRASIL, 2015). In Maranhão State, implementation of agricultural centers, such as the "Vila Residencial Nova Canaã" (HortCanaã), have been encouraged as compensation for the installation of a thermoelectric plant.

Considering the importance of the agricultural center, responsible for supplying markets in the region, the objective was to evaluate agroecological production systems at the HortCanaã center, through indicators of soil quality and crop health, as well as to contribute to the improvement of the relationship between scientific and empirical knowledge.

Methodology

The HortCanaã agricultural center in Paço do Lumiar municipality, Maranhão State (2°31›55››S, 44°06'28''O), has about 56 ha and since 2006 it has been used by the population affected by the installation of the Itaqui Thermoelectric Power Plant. The municipality is located in the metropolitan region of São Luís, about 26 km from the center of the capital. It has an area of 132,410 Km2 and population density of 890,24 hab/Km2 (IBGE, 2016). The predominant soil is Latosol (Yellow). Currently, at the agricultural center there are about 20 families that use the land mainly for the production of vegetables, papaya (*Carica papaya* L.), passion fruit (*Passiflora edulis* Sims), banana (*Musa paradisiaca* L.), cassava (*Manihot esculenta* Crantz), beans (*Phaseolus vulgaris* L.) and cupuaçu (*Theobroma grandiflorum* (Willd. ex Spreng.) K.Schum.); there are technical support, agronomist and social worker. In the area there is infrastructure consisting of sanitation house, aviary bed, shed, house to make flour, greenhouse and agricultural

expansion areas. Most farming methods are based on agroecological principles, with emphasis on the production of organic vegetables, which are sold in markets containing the family farming seal.

In October 2016, areas of polyculture containing maxixe (*Cucumis anguria* L.), okra (*Abelmoschus esculentus* (L.) Moench.), cassava (*Manihot esculenta* Crantz) and chives (*Allium fistulosum* L.) and cassava monoculture were evaluated. The methodology used to evaluate soil quality and crop health was proposed by Altieri and Nicholls (2002) and it was adapted by Machado and Vidal (2006), whose objective was to evaluate the management of the agroecosystem through indicators that are easy to estimate in the field. According to Machado and Vidal (2006), the indicators of crop sanity are related to functional diversity and agrobiodiversity; the soil quality indicators highlight its condition as a living organism and the focus on its ecological management. After the evaluation, amoeba-type graphs were elaborated in Excel 2016 Software, whose axes represent the general average of the groups of indicators, diagnosing which axis requires more attention within the system. Strategies have been suggested to improve the performance of indicators with lower scores.

Results and discussion

The results of soil quality for the cultivation of cassava (*M. esculenta*) are presented in Figure 1A. There was a prevalence of sandy soil, which favors the development of the roots of the species, since soaked soils cause rot (FILHO, SILVEIRA, 2012). The attributes of depth, softness, structure and soil cover were classified as lower performance systems. The soil was not completely covered in the cultivation area, therefore it is recommended to use green manuring consortium to cover the soil and cycling the nutrients. The presence of animals, soil conservation and decomposition indicators showed high values of sustainability, which is related to the practice of local farmers to add organic matter and other compounds of organic residues in the cassava cultivation. The practice was confirmed by the farmers during the survey.

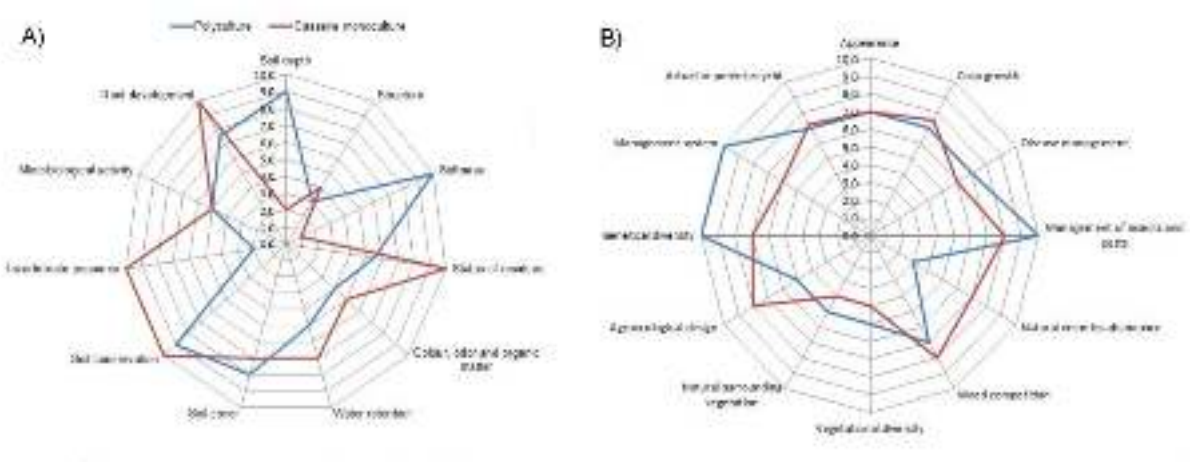

Figure 1. A) Amoeba representing the soil quality status of polyculture (blue line) and cassava monoculture (red line); B) Amoeba representing the crop health status of polyculture (blue line) and cassava monoculture (red line).

The results of sanitation for cassava monoculture are given in Figure 1B. The indicators with lower evaluations were: surrounding natural vegetation; diversity of vegetation and crops. For the implantation of cassava monoculture, extensive area of natural vegetation was suppressed; the area of the plantation was surrounded by other crops, for example banana plantation. Actions that assist in the restoration of native vegetation can bring benefits to the environment and to the cultivated area, such as maintaining or increasing organic matter, nitrogen fixation, nutrient absorption and recycling, soil protection against erosion, shading of crops that have restrictions on extreme solar radiation, reduction of acidity and salinity (NAIR, 1993).

The low diversity has direct and indirect effects under other indicators, so the most appropriate strategy for the improvement of this attribute is the insertion of crops that interact well with the cassava crop. The consortium favors the increase in productivity per unit area (MATTOS et al., 2005), soil protection against erosion, control of spontaneous plants (DEVIDE et al., 2009), reducing the incidence of pests and diseases in intercropped crops, thus can provide profit and food diversity for family farmers (ALVES et al., 2009). Beans, for example, a short-cycle cultivation, provide nitrogen fixation that can be used by intercropping plants. In addition, it is a common product in family farming, a source of food and income for many Brazilian farmers.

The results of soil quality for the polyculture of maxixe (*C. anguria*), okra (*A. esculentus*), cassava (*M. esculenta*) and chives (*A. fistulosum*) are presented in Figure 1A. The soil presented a superficial layer greater than 0.30 m, which characterizes soil with high depth. It is recommended the addition of crops with root systems that can develop in the

various layers of the soil and exploit this potential. The soil had a fragile structure, was loose, dusty, with no visible aggregates, but presented softness and decompression. In order to reverse conditions with low evaluation, the following actions are recommended: application of crop rotation system, use of organic fertilizers, green manure, chicken manure, bovine manure compounds with green Material and vermicompost, which are recommended to supply organic material, increase decomposition and microbial activity, stimulating edaphic life by the presence of renewed and varied rhizospheres (ALTIERI, 2002).

The results of sanity for the polyculture are given in Figure 1B. The cultures showed medium signs of nutritional deficiency, uniform growth and little damage. Thus, we can affirm that the management employed is meeting the requirements of the crops and the techniques of management of the diseases and pests adopted were satisfactory. At the time of analysis, in the afternoon, there were no insect pests in the polyculture, however it was verified low abundance and diversity of natural enemies, which probably can be explained by their diurnal behavior.

The medium-sized cassava crop succeeded in suppressing the growth and development of spontaneous plants. In addition, in this polyculture area, leaf mulch was used, which contributed to a decrease in the competition of the spontaneous plants with the crops. Only one side of the crop showed adjacent natural vegetation, which potentially influences the diversity of the agroecosystem. Because it contains four crops, the diversity of polyculture vegetation is average.

As for the management system adopted at the agricultural center, it was observed that the area is in transition between the use of agrochemicals and the use of natural products. For the fertilization it was detected that the chemical fertilizer was replaced by the biofertilizer produced in the study area. However, the use of agrochemicals by farmers is still common for pest control, and there is no reliability to assert the control method used specifically for cassava culture and polyculture.

Conclusion

The indicators revealed low diversity of natural and surrounding vegetation; deficiencies in structure, depth and microbiological activity in crops. Ecological practices such as green manuring and restoration of surrounding native vegetation are suggested to provide environmental sustainability for agroecosystems and to concretize the agroecological transition at the HortCanaã agricultural center.

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