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Homegardens management: improving soil fertility and total microbiological state (Case on Pacitan District, East Java, Indonesia)

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Abstract
Objective of this research was to explore the differences of soil fertility impact of homegardens system condition. The research was conducted in Pacitan Regency, East Java, Indonesia. Th ere was three homegardens system condition, namely active homegardens, passive homegardens and the critical land homegardens Observation held on 20 sites each homegardens condition. The observed soil properties parameters are pH, organic carbon, organic matter, total N, total P_2O_5, total K_2O, and total microorganism. The results showed active homegardens condition could improve significantly the soil fertility and total microorganism. Meanwhile, passive homegardens could not improve total microorganism even though had good soil fertility. Degraded homegardens had poor soil fertility and total microorganism.

Keywords
homegardens; soil fertility; total microorganism; Pacitan regency

Introduction

Increasing population is a challenge for food availability. One thing can be done to increase food sufficiency, security and self-sufficiency at the family or household level are through the use of homegardens. Homegardens as a potential agro-ecosystem can service family food sufficiency, and if it's properly developed can improve community welfare. Homegardens has a very complex vegetation structure, multipurpose function and serves as a form of potential agribusiness practices. Homegardens becomes a safety net for farmers, saviours of ecosystems and land management systems by synergizing the production and conservation of endangered plant species, and have economic value (Galuzzi et al., 2010; Lais et al., 2017).

Homegardens fulfils the principles of ecologic and social sustainability, where trees, seasonal crops, ornamental plants and other crops, as well as livestock can live together. Although the

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homegardens area is relatively narrow, it can produce food items such as tubers, vegetables, fruits, spices and medicine plants, handicraft materials, animal food ingredients derived from poultry, small livestock, fish, ornamental plants, building materials, firewood and animal feed. The benefits obtained from managing homegardens include being able to meet family consumption and nutritional needs, save expenses, can provide additional family income (Nurwati et al., 2015; Kusmiati dan Solikhah, 2015; Sukanata et al., 2015; Minarni, et al., 2017; Siregar and Wahyuni, 2018). Homegardens has various functions, namely social functions, commercial production functions, aesthetic functions, preservation of land and genetic resources or functions of food resource distribution. Exploiting the use of homegardens towards commercialization has resulted in many homegardens crops being sold to increase income to meet the needs of people whose economic income is still low. Several research results showed that there is a tendency to increase income from the use of homegardens in the economy of rural communities and can even support superior village products (Mulyanto, 2011; Susanto, 2014; Nurwati et al., 2015; Sukanata et al., 2015; Ratmono et al., 2016; Lais et al., 2017).

Pacitan is one of 38 districts in East Java Province, Indonesia. Topographical aspects of Pacitan show that the landscape varies with slopes ranging from flat, wavy, hilly and mountainous. Meanwhile, from the structure and type of soil, Pacitan consists of the Red Mediterranean Litosol Association, the grey alluvial clay sediment, the mixed Litosol Tuf with Vulkan and the Reddish Litosol Complex which contains many potential minerals. Soil is the main important component for the carrying capacity of a land's ability to use it by humans.

Homegardens is one form of agricultural management that is often used in Pacitan. However, the condition of the homegardens were not uniform. In general, there were three agricultural conditions in Pacitan, namely active homegardens, passive homegardens and degraded homegardens.

The term active homegardens, used to describe the condition of homegardens that was actively utilized by farmers in producing agricultural products and farmers actively and continuously provide some treatment such as fertilization, irrigation, pest control with the aim of improving agricultural products. The term passive homegardens, used to describe the condition of homegardens that was actively utilized by farmers in producing agricultural products but farmers did not actively and continuously provide some treatments such as fertilization, irrigation, pest control with the aim of increasing agricultural products. The term degraded homegardens, used to describe the condition of homegardens that was not utilized by farmers in producing agricultural products and farmers did not actively and continuously provide some treatment to maintain the condition of homegardens.

Differences in homegardens conditions are believed to had an influence on fertility conditions and soil microorganisms. This agricultural activity is carried out actively by farmers could maintain and even improve soil fertility conditions and soil microorganisms.

Soil fertility is a condition which the soil can support plant growth with its various components, such as biology, chemistry, and physics. The carrying capacity of homegardens land is the maximum capacity of the environment to be empowered, without causing degradation of resources regarding physical, environmental, social, economic and cultural aspects. The sustainability of land carrying capacity is largely determined by a land management (Widyawati and Rizal, 2015).

Land management aims to assist in optimal plant growth and development. Damage to the soil environment in the wet tropics including in Indonesia, apart from being caused by an ecosystem that is conducive to soil degradation, also spurred by intensive soil management. Realizing an integrated agricultural system on homegardens are not easy for the community, especially because of the limited information that reaches them. Referring to this, it is necessary to conduct an assessment of the different types of land

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management in the homegardens on microbiology conditions and soil fertility. The hope is that it can provide information to the homegardens farming community about the best land management in maintaining the biological condition of the soil as well as soil fertility which will have implications for the results of the homegardens.

Methods

Study Area

The research held on Pacitan, East Java, Indonesia. Pacitan is located at 7 92 '- 8 29' South Latitude and 110 90' - 111 43' East Longitude. There were three homegardens management: active homegardens, passive homegardens (with low maintenance) or critical land and homegardens with degraded land. This research was used 20 observation sites that spread over 10 sub-districts: Pacitan city, Kebonagung, Lorok, Nawangan, Sudimoro, Pringkuku, Punung, Tulakan, Arjosari and Tegalombo (Figure 1). All of the location have varied topografi (plain, hills and highlands). The Data collected on June – August 2020.

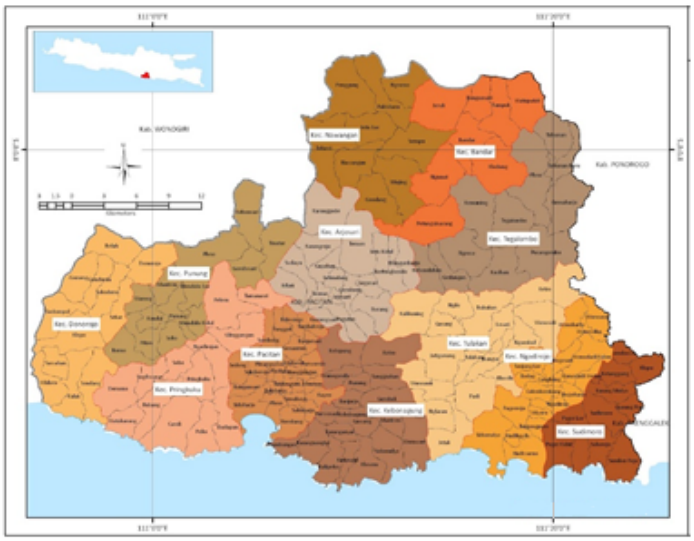

Figure 1. Research study area (Source: Pacitan-East Java, Indonesia Goverment).

Research methods

There were three homegardens management: active homegardens, passive homegardens (with low maintenance) or critical land and homegardens with degraded land. Every homegardens management has 20 location were observed. Several parameters were used to determined the soil fertility state: pH, organic carbon, organic matter, Total N, Total P2O5, total K2O. Total microorganism was used to determined biological condition.

pH meter was used to measure pH soil. Weigh 10.00 g of dry soil sample placed on 250 ml beaker glass, add 50 ml of aquadest stir until homogen with vortex. Shake with a whisker for 30 minutes. Suspension was measured by a calibrated pH meter using buffer solution pH 7.0 and pH 4.0 (Rayment and Higginson 1992; van Reenwijk, 1993; Chakraborty and Mistri, 2015).

Organic carbon and organic matter determined with Walkey Black method. Weigh 0.500 g soil sample size <0.5 mm, put in 100 ml volumetric flask. Add 5 ml of K2Cr2O7 1 N (dissolve 98.1 g of potassium dichromate with 600 ml of aquadest in beaker glass, add 100 ml of concentrated sulfuric acid, heat it until dissolved perfect, once cold diluted in a volumetric flask 1 l with aquadest), then shake. Add 7.5 ml H2SO4 concentrated, shaken and let stand for 30 minutes. Diluted with aquadest, let cool and settle. The next day measured the absorption of the clear solution with spectrophotometer at 561 nm wavelength. Glucose solution 0 – 250 ppm used as standard (Page, et al., 1982).

Determination total N used Kjeldahl method. Weigh 0.500 g sample soil size <0.5 mm, input into tube digest. Add 1 g of selenium mixture (1.55 g CuSO4 anhydrous, 96.9 g Na2SO4 anhydrousand 1.55 g selenium) and 3 ml of concentrated sulfuric acid, destructed up to 350 °C (3-4 hours). The destruction was completed when white steam comes out and obtained clear extract (about 4 hours). The tube was lifted, cooled and then extract diluted with aquadest exactly 50 ml. shake until homogen, leave overnight to particles settle. Extract used for N measurement. Pipettes into the test tube each 2

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ml extract and standard series. Add tartrat buffer solution (Weigh 50 grams of NaOH p.a. powder and dissolve slowly while stirred with about 500 ml aquadest put in 1000 ml volumetric flask. After add 50 g of K powder, Na-tartrate and stir until dissolved. Dilute with aquadest up to 1000 ml) and Na-fenolic (weigh 100 g of NaOH p.a. powder and dissolve it slowly while stirred with about 500 ml aquadest placed in 1000 ml volumetric flask, add 125 g of phenol powder and stir until dissolved, diluted with aquades up to 1000 ml) respectively as much as 4 ml, shake and leave for 10 minutes. Add 4 ml NaOCl 5 %, shake and measured with a spectrophotometer at a wavelength of 636 nm after 10 minutes since the giving of this reaction. (NH4)2SO4 solution 0 – 20 ppm was used as standard (Page, et al., 1982).

Total P2O5 and total K2O determination was used HCl 25% extraction. Weigh 2,000 g of soil sample size <2 mm, put in a bottle shake and add 10 ml HCl 25% then shake with the shake machine for 5 hours. Put in the test tube left overnight or sentrifuge. Pipette 0.5 ml clear extract sample into the test tube. Add 9.5 ml of aquadest and shaken. Pipette 2 ml dilute sample extract and the standard series are each inserted into the test tube, then added 10 ml of dye reagent solution P (Combine 1.06 g of ascorbic acid and 100 ml of concentrated P reagents, this P reagent should be
always made new; concentrated P reagents: dissolve 12 g (NH4)6 Mo7O24.4H2O with 100 ml aquadest put in volumetric flask 1000 ml, add 0.277 g K(SbO)C4H4O6 0.5 H2O and slowly 140 ml H2SO4 concentrated, diluted until 1000 ml with aquadest) and shaken. Left for 30 minutes, then measure its absorbance with the spectrophotometer at wavelengths 693 nm. For potassium, diluted sample extracts and standard K series are measured directly with flamefotometer instrument (Sudjadi, et al., 1971).

Total microorganism determination used pour plate method. The sample to be tested was taken aseptically and weighed as much as 1 g, then put in steril plastic. Add 10 ml buffered phosphate butterfield solution (Stock solution: 34 g KH2PO4; 500 ml aquadest, set pH 7.2 with NaOH 1 N, dilute up to 1000 ml with aquadest, sterilization for 15 minutes at 121 °C, store in refrigerator; Working solution: pipette 10 ml stock solution and diluted up to 1000 ml with aquadest. sterilization for 15 minutes at a temperature of 121 °C), homogenize for 2 minutes. This homogenate is a dilution of 10-1. Using a sterile pipette, take 1 ml of homogenate above and put in 9 ml of butterfield phosphate buffered solution to get dilution 10-2. Also create for the next dilution in the same way. At each dilution is carried out a minimum of 25 times. Pipette 1 ml of each dilution and put in a sterile petri dish. Do it duplo for each dilution. Add 15 – 20 ml of cooled Plate Count Agar (5 g tryptone, 22,5 g yeast extract, 1 g dextrose, 15 g agar, 1000 ml aquadest, heat the whole ingredients until boiling, sterilization for 15 minutes at a temperature of 121 °C) in waterbath, heat to a temperature of 45 °C into each cup that already contains a sample. So that the sample and PCA media mix perfectly do the cup playback forward to back and left to right. After becoming solid, for the determination of aerobic microorganisms, the incubation of the cups is in an inverted position in the incubator at a temperature of 35 °C for 48 hours. For the determination of anaerobic microorganisms, incubation of the cups is in an inverted position in an anaerobic jar and put in the incubator for 48 hours at a temperature of 35 °C. Perform control without sample by mixing a dilutive solution with PDA media. Calculate the number of colonies per petridish with colony counter tool (Page, et al., 1982).

Statistic analysis

The data that has been obtained will be carried out statistical testing using One Way ANOVA and Duncan't analysis 5% with SPSS for windows version 25. The test results will provide information about the conditions of the three homegardens categories.

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Results and Discussions

The study was conducted on the effect of treatment that occurs in the community on the homegardens in affecting soil fertility and total soil microorganisms. In general, there are three types of treatment, namely the homegardens which is left abandoned without any activity (degraded homegardens). Second, the homegardens which is managed by the community in a minimalist manner, (passive homegardens). Third, the homegardens that is managed regularly (active homegardens).

Observations of the three types of homegardens included several variables, namely pH, organic carbon, organic matter, total N, total P_2O_5, total K_2O and total soil microorganisms. Observation of the variables above is intended to determine the extent of differences in activities in the homegardens that occur in the Pacitan community with soil fertility levels and soil microbial conditions. The results of the research on the three types of homegardens are shown in the table 1.

Table 1. *Soil biological properties and total microorganism.*

Home garden	pH (H_2O)	C organic	Organic matter	Total N	C/N ratio	Total P_2O_5	Total K_2O	Total microorganism
		%				mg/100g		X10000 (col/g)
Degraded	4.80 a	1.68 a	2.90 a	0.09 a	18.58 b	9.19 a	6.32 a	0.35 a
Passive	5.04 b	2.92 b	5.03 b	0.20 b	14.64 a	17.05 b	16.76 b	5.40 b
Active	5.36 c	4.59 c	7.92 c	0.32 c	14.21 a	26.22 c	26.72 c	61.2 c

The results showed that the existence of agricultural activities, both passive and active, provided a significant improvement in soil fertility. This can be seen from the increase in the value of organic carbon, organic matter, total N, P_2O_5 and K_2O and a decrease in the value of C/N ratio. Besides, activities in the homegardens provide significant improvements to the total soil microorganisms. The increase in soil fertility is due to the input activity on the soil as a planting medium. The input that is usually carried out in farming activities, first, fertilization using organic fertilizers (Kochakinezhad et al., 2012; Lin et al., 2019). Organic fertilizers come from organic waste leaves or other materials as well as livestock manure, such as chicken, goat, cow manure and so on. Organic fertilization has benefits in providing nutrients for plant growth. Beside, it also helps improve soil fertility, providing nutrients more continuously and sustainably. Besides that, it also helps create bioflores which increase the development of soil microorganisms which are useful in helping supply nutrients.

Second, soil loosening. Land loosening is often done by people in their homegardens to make the media loose and it is believed to be able to help plant growth and development better. Scientifically it can be explained that with the process of soil loosening, the soil structure of the soil porosity increases (Schjonning et al., 1998). This helps the entry of air into the ground so that the soil becomes more aerobic. More aerobic conditions help soil microorganisms to reproduce and help provide nutrients due to the decomposition process carried out by soil microorganisms. Increased soil porosity will help water-holding capacity, this is due to the space in the soil that can be filled by water. Unlike the solid soil, the water given during watering will flow and not enter the ground. Third, periodic watering. The action of watering is an action that helps in increasing plant growth as well as increasing soil fertility. Water in plants is an important metabolic medium. Meanwhile, soil that contains sufficient water will be more fertile. This is because water is needed for the decomposition process that is useful in providing nutrients (Van Noordwijk

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and Verbist, 2000; Thomas et al., 2013; Sailendra et al., 2014). The different types of treatment in the homegardens gave different status criteria for soil nutrients. The following are the criteria for nutrients in the three types of homegardens (Table 2).

Table 2. *Status of nutrient criteria in the three types of homegardens.*

Soil Parameter	Degraded homegardens	Passive homegardens	Active homegardens
pH	Very acid	Acid	Acid
Corganic	Low	Medium	High
Total N	Very low	Medium	Medium
C/N ratio	High	Medium	Medium
Total P2O5	Very low	Low	Medium
Total K2O	Very low	Low	Medium
(Data source: research data)			

The table above showed that the existence of management activities in the homegardens provides an increase in nutrient criteria in the homegardens area. This show that the management of homegardens land, even though it is a minimum, is still needed to maintain the fertility status of the homegardens or even to increase the fertility status of the homegardens. Land fertility that is maintained and even increases will provide an increase in the production of cultivated crops.

Conclusions

Good homegardens management was proven to could able to improved soil conditions in terms of fertility and soil microorganism life.

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