

Sulawesi cacao (*Theobroma cacao*, L.) performances under two different agricultural system in east coast of Central Sulawesi

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Abstract. Cacao (*Theobroma cacao* L.) is one major agricultural commodity from central Sulawesi, which is significantly affected by a range of pest and diseases including Cacao Pod Borer (CPB), Pod Rod Diseases (PRD), and Vascular Streak Dieback (VSD). Intensive and extensive approaches, including introduction of various new superior cultivars/clones, and development of eco-friendly agricultural system were implemented in order to overtake that problem. Here, we observed the performance of three different clones (namely: Sulawesi 1, MCC01, and Tadulako-1) in two different locations (Parigi and Poso-which located along east coast of central Sulawesi province), and under two different Agricultural management system (eco-friendly-intensive and Non-Intensive). All clones tested showed their well-adapted and suitable to local conditions. The performance of each clone can be improved by intensive management system. Based on all observed parameters (number of wet bean per pot, bean count, fat and shell percentage, and percentage of infection) it convincingly showed that intensive management system was working well in improving the quality and quantity of cacao beans production, and it fit to commercial requirements. The highest rate of infection was by *Phytophthora* and no significant differences on the overall performances. Clones of Sulawesi-1 and MCC01 most likely was better than Tadulako-1.

1. Introduction

Cacao (*Theobroma cacao* L.) is not endogenous Indonesian agronomic plant. This agronomic plant was introduced from South America, which has three different ancestor called as Criolla, Foresterio, and Trinitario [1]. The present time we can found various cultivars of Cocoa with very different kind of phenotypic characters. It is believed that cultivars are the current plant after natural adaptation into local condition. In Central Sulawesi, there were more than 20 clones (such as Sulawesi 1, Sulawesi 2, ICCRI, MCC etc.) that have been identified and cultivated by local farmer [2].

Statistically, Central and South Sulawesi contribute more than 60% (more than 250 thousand ton) of annual cacao bean for national product [3]. Unfortunately, cocoa farming is affected by a range of pest and decreases with the estimated average loss 30-40% of total production [4]. The serious cases including; Pod Rot known as Black Pod (caused by the fungus of *Phytophthora* spp.) causes global



yield loss of 20-30% and tree deaths of 10% annually), Vascular-streak dieback (VSD)(caused by the fungus of *Oncobasidium theobromae*, causes heavy loss of trees in mature plantations), and Cocoa Pod Borer (CPB)(caused by the insect of *Conopomorpha cramerella*, inflicts loss of US\$ 40 million per year). These are serious threat causing vast losses in the cacao farming in Sulawesi.

Cacao farms is widely distributed over Central Sulawesi area, including in highland such as Kulawi and Palolo, or in beach areas such as Parigi and Poso (which located in Eastern coast of Sulawesi island), and also in lowland and west coast of Island, such as Dolo, Donggala, and Toli-toli. The different areas show their local conditions including microclimate. Due to these local conditions and lack of information related the resistance again pathogen of each cultivar in different local condition, here in this study we determine the status of productivity and the resistance to main pest and diseases, also the quality of yield from three different cultivars in two east coast locations (Parigi and Poso), which supply significantly in production of cacao bean. Moreover, we also describe the effect of cacao farming management (we called echo friendly intensive farming) compared to the conventional one.

2. Material and method

This observation was done continuously from February 2013 to April 2014. Sampling was taken up based on the randomized block design in Split-Plot pattern, from two locations (Poso and Parigi). The main plot was three different of clones (cultivars) i.e. Sulawesi 1, MCC01, and Tadulako-1, while as sub-plot were two different management systems i.e. echo friendly intensive and conventional (Nonintensive) Agricultural system. The subject plants as samples were clones propagated by grafting in 2008. The designed locations are listed in Table 1.

Table 1. The designed locations

No.	Management system	Location	coordinates	Altitude (m above sea level)
1.	Echo-friendly Intensive	Parigi	S 00° 56.919' E 120° 13.002'	182
2.	Echo-friendly Intensive	Poso	S 01° 18.943' E 120° 35.171'	82
3.	Non-Intensive (conventional)	Parigi	S 00° 56.453' E 120° 12.981'	47
4.	Non-Intensive (conventional)	Poso	S 01° 18.903' E 120° 13.002'	48

Eco-friendly Intensive Management system that we introduced to the farmer, can be described as intensive in choosing clone for grafting, regular pruning, and using organic material for fertilizer, insecticide and pesticide applications, but during rate of pathogen attack (e.g. during wet season), farmer can use chemical commercial materials in minimum amount. While conventional system refer to non-intensive management, using commercial fertilizer, and applying insecticide, and pesticide in high dose, without combination to the organic compound.

Observed parameters were quantity and quality of yield and rate of pest and diseases infection from sample of each plot. Sampling was done during period of April and November.

3. Result and Discussion

In this study, we observed 45 plants as sample for each plot, so in total, we observed 270 plants from each location. Firstly, we observed the infection rate on each clone in those locations by measure the infection rate of CPB (Cacao Pod Borer), *Phytophthora*, and VSD (Vascular-streak dieback). The outcome can be seen in Figure 1 and 2. The management system showed significant effect in reducing infection rate of these three pathogens. CPB and VSD can be controlled until zero by this intensive system, while infection due to *Phytophthora* can be eliminated. It could be the fact that fungi are difficult to be controlled during wet season. During rainy season, the spore of *Phytophthora* easily

dispersed growth and infected the cacao pod [5-6]. In both locations (Poso and Parigi), *Phytophthora* show still dominant diseases compared to CPB and VSD.

The low rate of infection here also indicates that three observed clones have high resistance again CPB, *Pythoptora*, and VSD infections. Since these three clones are resulted from breeding and selection program and it could be superior clones and suitable for the local condition of Central Sulawesi, especially in east-coast area.

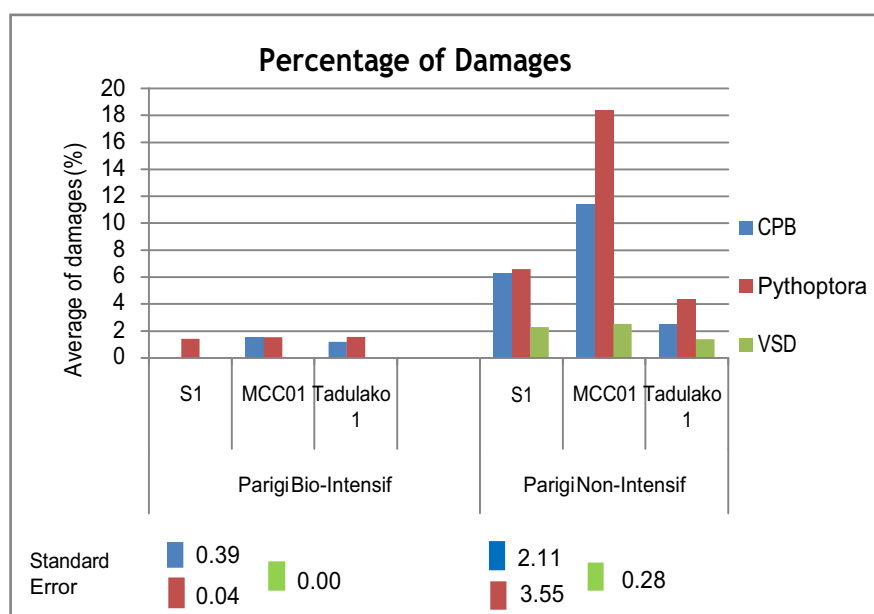


Figure 1. Infection rate of CPB (Cacao Pod Borer), *Phytophthora*, and VSD (Vascular-streak dieback) on three different cultivars of cacao) from two different management system in Parigi.

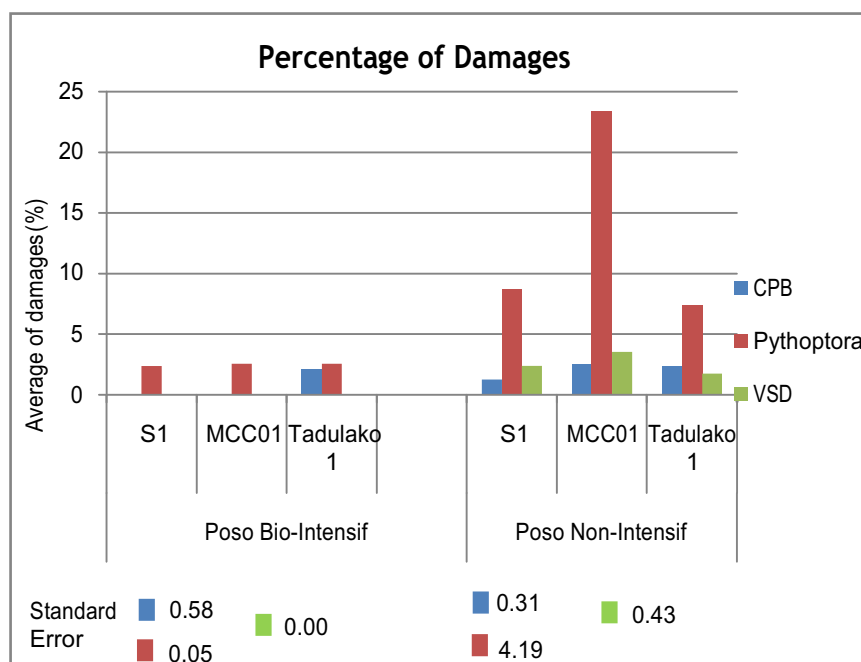


Figure 2. Infection rate of CPB (Cacao Pod Borer), *Phytophthora*, and VSD (Vascular-streak dieback) on three different cultivars of cacao) from two different management system in Poso.

The quality and quantity of yield from this area were observed based on the seed number, fresh weight of bean (wet bean), shell content, and fat content of bean from each clones and from each location. Bean count referred to number of bean in 100 g. This number was not only depend on genetic properties but also can be proved by good management system. The data of bean account is presented in Figure 3.

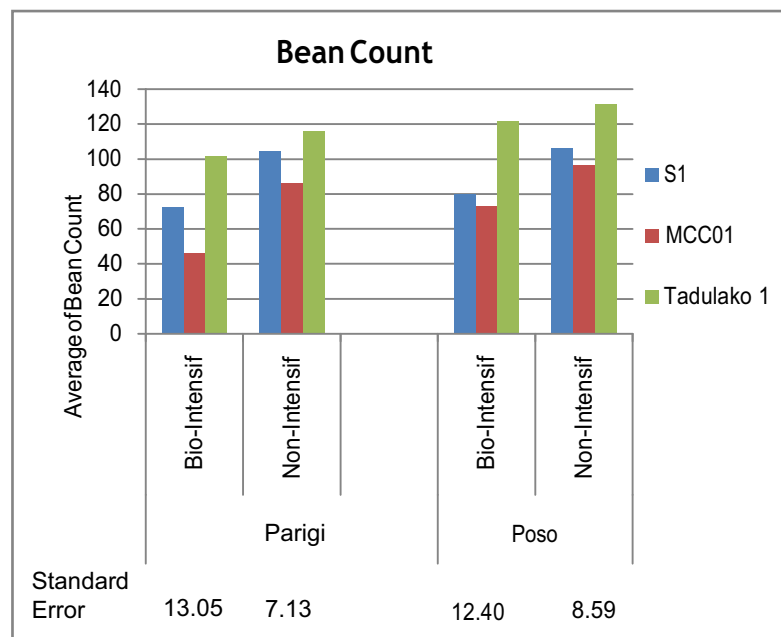


Figure 3. Number of beans on 100 g. Data was collected from each plot from Parigi and Poso farms cultivated by applying two different systems (echo-friendly intensive and non-intensive-conventional). Intensive system in the farm on those three clones, it could increase the size of produced bean.

Produced bean can be improved by applying the intensive management of cacao farming. The each bean become bigger and heavier when plant healthy. In intensive system, plant could be supplied enough nutrition, enough light for carrying photosynthesis, and less pest and pathogen infections as similar case reported in Ivory Coast [7]. As a result, the plants can grow better than it under conventional agronomic system. Figure 3 also indicates that plant growth condition in Parigi is better than in Poso. It shows that the nutrition status in Parigi is more suitable for cacao plant than that of in Poso for all clones. However, clones of tadulako-1 produces smaller/lighter of bean compared to bean of MCC01 and Sulawesi-1. Clone of MCC01 has higher sensitivity in case of bean size, compared to other clones. The bean weight of MCC01 is easily improved if we apply the echo-friendly intensive system.

Furthermore, we also observed the quality of bean by observe the shell content and fat content. Shell content on dried bean is parameter that cacao bean produced in the farming, are less of unexpected contaminants. While fat content is important parameter in case of chemical properties. Data from measurement of shell content and fat content are presented in Figure 4 and 5, respectively. Our data showed that there were no significant difference on shell content and fat content of bean produced from two different management system. The differences only can be detected in between clones. It seems that genetic factor is more dominant than environmental factors. The data also suggests that genetic potency of Tadulako-1 is lower than Sulawesi-1 and MCC01 properties.

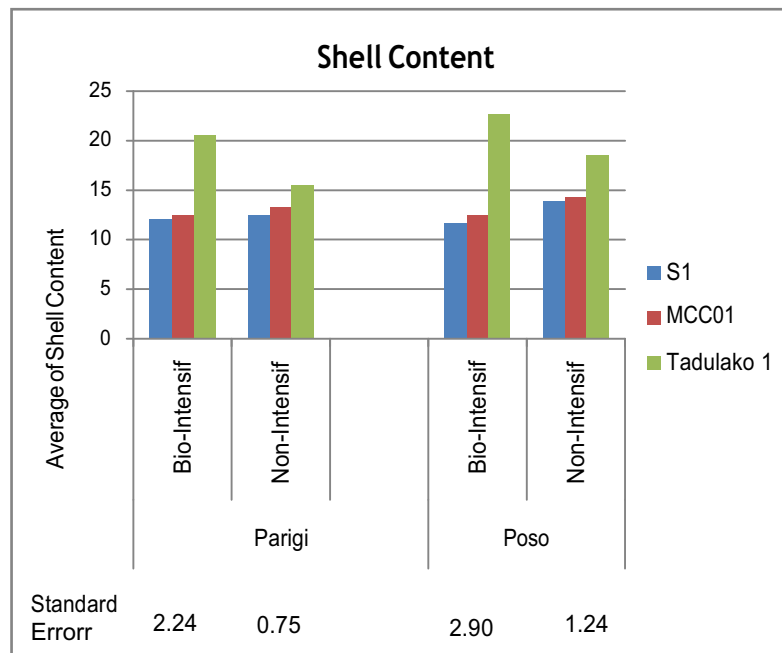


Figure 4. Percentage of shell content on dried beans produced by three different clones (Sulawesi-1, MCC01, and Tadulako-1) from farming area of Parigi and Poso implementing echo-friendly intensive and non-intensive agricultural system.

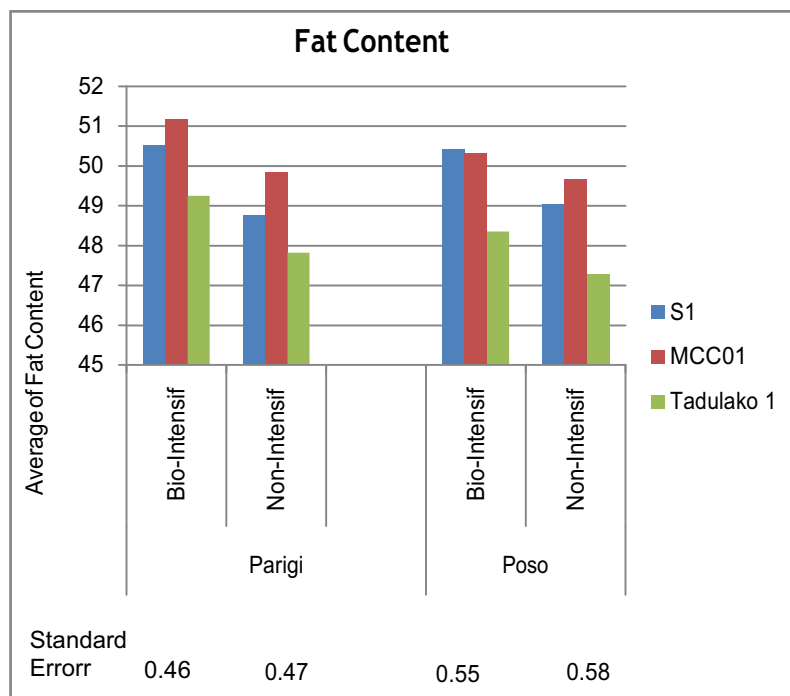


Figure 5. Fat content on dried beans of three different clones (Sulawesi-1, MCC01, and Tadulako-1) from farming area of Parigi and Poso implementing echo-friendly intensive and non-intensive agricultural system.

Altogether, it shows that clones of Sulawesi-1 and MCC01 are better than Tadulako-1 clone. Although all clones are suitable for Parigi and Poso condition, the genetic potency of Sulawesi-1 and

MCC01 can be improved by improving the ecologic condition as also reported before[8]. The tested clones give response to the ecological condition that build-up by applying good eco-friendly-intensive management system. We recommend to farmer in Parigi and Poso to use clones of Sulawesi-1 and MCC01 for cultivating (by grafting) and practicing in eco-friendly system for their cacao farming.

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