

# Good Agriculture Practice (GAP) of arabica coffee (*Coffea arabica* L.): Implementation on the smallholder estate in Enrekang Regency

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# 1 Good Agriculture Practice (GAP) of arabica coffee (*Coffea arabica* L.): Implementation on the smallholder estate in Enrekang Regency

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**Abstract.** This study aims to evaluate and provide an overview of farmers' knowledge and understanding on the Good Agriculture Practice (GAP) of Arabica coffee cultivation and its implementation level on the smallholder estate in Enrekang Regency. The research was conducted in three districts of coffee plantation centre from December 2017 to January 2018. The research was carried out in the form of surveys including interviews, observations, and literature studies. A total of 30 respondents were selected using a purposive sampling method in addition to several key respondents from stakeholders and experts. Criteria for the selection was based on the involvement of the farmers in a GAP field schools or not. A proportional ratio of farmers involved in program and not involved were set for the survey. Data were analysed descriptively and quantitatively using comparative analysis with SPSS Version 16 to determine the difference in production of two groups of farmers. The results show that the overall implementation level of GAP by the smallholder farmers of Arabica coffee in Enrekang Regency is 54%. Highest level of GAP implementation was on post-harvest aspect (77%), followed by the harvest aspect (61%). The smallholder coffee farmers had the lowest GAP level on in cultivation aspect of 24%. Farmers that did not implement the GAP had a significantly lower production compared to the farmers who have participated in GAP field schools.

## 1. 7 Introduction

Coffee (*Coffea* sp) is an export commodity that provides an adequately foreign exchange, especially from plantation commodities that involve several producing countries and many consumer countries. Coffee plays an important role in international trade in the form of coffee beans, instant coffee or in other forms. Two types of coffee plants in the world that are often used are Arabica and Robusta. Coffee are grown in almost all Indonesian mainland and mostly cultivated in smallholder estates. To fulfill the requirements, the processing of this farmers' coffee must be done in a timely and appropriate manner and in the right amount as well as other agricultural products [1].

Coffee commodity can contribute in the acquisition of added value to the base area, so that this commodity can support the development of plantation activities in Indonesia. In the micro scope, coffee farming, especially Robusta, will provide income of a and IDR.9 million per hectare per year while Arabica coffee farming can generate income reaching IDR.19 million per hectare per year [2]. During this period of year, the price of Arabica coffee was around USD. 2.72 per kilogram or equivalent to IDR. 25,600 per kilogram with an exchange rate of IDR.9,400 per USD (ICO, 2014). This condition shows



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that coffee business can contribute significant<sup>21</sup> to the income to the farmers' households. The composition of ownership of coffee plantations in Indonesia is dominated by smallholder plantation with a share of 96% of the total area in Indonesia, and the remaining of 4% is the state large plantation and private large plantation [3]. This position shows that the role of coffee farmers in the national economy is quite significant. This means that the success of Indonesian coffee will directly improve the welfare of farmers.

South Sulawesi Province as an area of Arabica coffee plantations with the status of smallholder plantations contributes to the national coffee production in Indonesia. Data from the Directorate General of Plantations [4] shows that the area of Arabica coffee plantations in the category of smallholder plantations in South Sulawesi Province in 2016 was around 46,519 ha with a total production of 19,534 tons and productivity of 633 kg / ha spread across several districts. Special Arabica coffee is found in Enrekang District (Kalosi Specialty Coffee) and Tana Toraja (Toraja Specialty Coffee), regular Arabica coffee (class I Arabica) is found in Gowa and Bantaeng Regencies. Robusta coffee types are widely developed in the districts of Bulukumba, Bantaeng, Sinjai, Pinrang, Luwu, northern Luwu, and Tana Toraja [5].

Enrekang Regency is one of the regions in South Sulawesi that has the potential for developing Arabica coffee because of its relatively large planting area and very supportive environmental and agro-climatological conditions. One of the best types of Arabica coffee in the world which is only produced in Enrekang has been widely known abroad as the Kalosi Specialty Coffee and has obtained the Geographical Indication Certification (GIS) in 2013. Since a few years ago, this Kalosi coffee has been exported to foreign countries with high prices, such as to Germany, Japan and America. This coffee is loved abroad because of its distinctive taste and aroma.

Arabica coffee production in Enrekang Regency was not directly proportional to the increase in planted area. Growing condition and cultivation techniques are among factors that affect the yield of this commodity. The quality is influenced by the physical variables of the place of production such as the altitude, rainfall, slopes, vegetation around the coffee plant, as well as the culture in coffee cultivation, and coffee processing technology [6]. The physical condition in one region certainly cannot be found exactly in another region.

Another factor that also influences coffee quality in addition to these physical factors is the cultivation factor in coffee plantations. The cultivation factor is a factor that is influenced by humans, in contrast to physical factors that are influenced by natural conditions. Coffee cultivation factors include techniques for providing production facilities, production processes, post-harvest handling and processing techniques, and marketing systems [7].

To increase coffee production and productivity, farmers need to be equipped with knowledge about coffee cultural technical guidelines or often called Good Agriculture Practice (GAP). GAP is a standard of work that is applied in every agricultural business so that production can meet international standards. One of the efforts made by government is by conducting GAP Field Schools (GAP-FS) for coffee commodity. The implementation of this method is intended to increase the productivity and quality of products produced by farmers to meet consumer needs and have high competitiveness compared to their counterparts from overseas.

## 2. Methodology

The study was conducted in three districts of Enrekang Regency, South Sulawesi Province, namely Masalle, Baroko, and Baraka Districts. The selection of research sites was done using a purposive sampling method with the consideration that the selected area was the production centers for Arabica coffee and had coffee production and productivity with the potential for good coffee plant development. The study was conducted from December 2017 to January 2018.

### 2.1. Research methods

The research was conducted in the form of a survey (interviews, field observations, and literature study). The selected respondents were coffee farmers with a minimum of 5 years of farming and the condition

of the coffee plants that are already in production. 10 samples per district were determined from the total population of coffee farmers at the study site. Respondent consisted of five farmers who had participated in and implemented the Good Agriculture Practice (GAP FS) and five farmers who had not yet participated in the program. A total of 30 respondents were obtained. In addition to respondents from farmers, interviews were conducted with key respondents/stakeholders, namely Head of the Agriculture and Plantation Office of Enrekang Regency, extension staff, the chairperson of the local farmer group association (Gapoktan) in each district, and coffee experts.

## 2.2. <sup>12</sup> *Types and data collection methods*

The type of data used in this study were primary and secondary data. Primary data were data collected from information retrieved from the field by filling out the questionnaire systematically, direct interviews with stakeholders including farmers, government and private sectors, and observing the object of the research to obtain the real condition. Secondary data were collected through research and review of the literature that is relevant to the problem being studied.

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## 2.3. *Data analysis method*

*2.3.1. Analysis of the implementation level of GAP for coffee.* Data and information collected in this study were then tabulated and analysed using a qualitatively and quantitatively of descriptive analysis. Data on the implementation of GAP, consisted of three aspects ie. cultivation, harvest and post-harvest aspects. The data were analysed by making a frequency distribution table based on parameters used as indicators.

*2.3.2. Comparative analysis of coffee yield.* Coffee crop production data was analysed comparatively by comparing the yield obtained by GAP FS farmers and non-GAP FS farmers who do not apply GAP. The comparative analysis was carried out using the SPSS Version 16. The conclusion was made based on several conditions below.

Hypothesis:

H0 = Variation of coffee yields of GAP FS farmers and non-GAP FS farmers have no significant difference.

H1 = Variation of coffee yields of GAP FS farmers and non-GAP FS farmers have a significant difference.

Decision criteria:

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a) If the probability (Sig.) > 0.05 then H0 is accepted;

b) If the probability (Sig.) < 0.05 then H0 is rejected.

## 3. Results

### 3.1. *Implementation of GAP on the Smallholder plantation of Arabica Coffee*

The implemented level of coffee GAP by the respondent farmers in the three districts of Enrekang Regency is shown in table 1. Table 1 presents a recapitulation of data on the implementation of Good Agricultural Practices conducted by farmers. In the aspect of cultivation consists of 12 sub aspects, namely variety, spacing, size of the planting hole, the length of the hole made before planting, shading tree types, type of fertilizer, fertilizer dosage, fertilization method, type of pruning, time of pruning, sanitation activities, and finally, pest control and disease. In the aspect of harvesting consists of three sub aspects, namely the interval of harvesting, picking intervals, and service delivery. And the post-harvest aspect consists of one sub-aspect, namely post-harvest treatment.

**Table 1.** The level of implementation of Good Agricultural Practices (GAP) of coffee Arabica by respondent farmers in Enrekang Regency.

Aspect	GAP Coffee [3]	Implementation at farmers level*
<b>Cultivation aspects</b>		
Variety	USDA 762	7%
	Lini S 795	47%
	Kartika 1	17%
Planting distance	18 m x 1.5 m	7%
	2.5 m x 2.5 m	30%
	20 2.0 m x 2.5 m	13%
Planting hole	60 cm x 60 cm x 40 cm	27%
Preparation of the planting hole before planting	6 months	7%
Shade plants	Lamtoro ( <i>Leucaena leucocephala</i> )	23%
	Dadap ( <i>Erythrina subumbrans</i> )	13%
Type of fertilizer used	Organic	13%
Fertilizer dosages	Organic: 10-20 kg/tree	13%
	Inorganic: 425 g/tree	40%
	500 g/tree	23%
Fertilizer application	Placed in a circular hole	17%
	Buried in a hole near the root	17%
Pruning	Pruning for shape formation and production	63%
Pruning frequency	Once a year	77%
	Twice a year	3%
Sanitation	Restore coffee skin after harvest and prune branches that are attacked by pests and diseases	30%
	Pest and disease control using traps	27%
Average for cultivation aspect		24%
<b>Harvest aspect</b>		
Harvest frequency	Once a year	100%
	Twice a year	0%
Harvest period	10-14 days	43%
Harvest criteria	Selective picking for cherries (ripe coffee).	100%
Average for harvest aspect		61%
<b>Post-harvest aspect</b>		
Post-harvest treatment	Fermentation	77%
Average for post-harvest aspect		77%
Overall implementation:	1. Cultivation aspect	24%
	2. Harvest aspect	61%
	3. Post-harvest aspect	77%
Overall GAP implementation		54%

\*Data are average from three districts (Baraka, Baroko, and Masalle) for the implementation of each aspect of GAP.

The recapitulation results for all aspects, reveals that the levels of GAP implementation in the study sites varied from the lowest percentage of 3% and the highest percentage of 77%. The average percentage of the application of GAP in the aspect of cultivation is still low at around 24%. In the harvest

aspect, GAP implementation still varies, starting from the lowest application, which is 0% and the highest is 100% and the average level of GAP implementation in the aspect is quite high, which is around 61%. In the post-harvest aspect, the percentage of implementation in accordance with GAP is around 77%. The average implementation of GAP applied by farmers in Enrekang Regency is 54%.

All respondents consisted of 50% of the GAP FS farmers who had implemented the GAP and 50% of farmers had not yet followed the program. Therefore, it is expected that the level of implantation of the coffee GAP is at least a 50% from all respondents. However, from the recapitulation results obtained of GAP implementation in Enrekang district, it indicates about 4% of the non-GAP FS farmers or farmers who have not participated in the GAP field school have also implemented a good practice.

### 3.2. Comparative analysis of productivity of the GAP FS farmers and Non-GAP FS farmers

The productivity results obtained by respondent farmers in three districts in Enrekang Regency are shown in table 2. Direct comparison of productivity were converted into kg / tree. In Baraka District the highest productivity was obtained for farmers who had applied GAP of 0.72 kg / tree and the lowest was 0.23 kg / tree while farmers who had not applied GAP or non-GAP FS farmers had the highest productivity at 0.33 kg / tree and the lowest 0.11 Kg / tree. Similarly, in Baroko District, GAP FS farmers had higher productivity (ranged from 0.31 to 0.51 kg / tree) compared to non-GAP FS farmers with productivity ranged from 0.12 to 0.21 kg / tree. In the District of Masalle, productivity obtained by farmers who have applied GAP was in the range of 0.29 to 0.50 kg / tree, while farmers that did not apply the GAP had lower range of productivity of 0.16 to 0.32 kg / tree.

**Table 2.** Productivity of Arabica coffee of respondent farmers who have attended the Good Agriculture Practice (GAP) field school (GAP FS farmers) and did not attend the field school (Non-GAP FS farmers) in Enrekang Regency.

Location/District	Productivity (kg per tree)	
	GAP FS	Non-GAP FS
Baraka	0.55	0.14
	0.23	0.33
	0.72	0.19
	0.54	0.16
	0.55	0.11
Baroko	0.44	0.21
	0.31	0.15
	0.36	0.12
	0.38	0.21
	0.51	0.14
Masalle	0.32	0.20
	0.33	0.25
	0.44	0.32
	0.29	0.16
	0.50	0.23

Arabica coffee productivity in Baraka, Baroko, and Masalle Districts of the Enrekang Regency were analysed using independent sample t test analysis. This test is used to determine whether there is an average difference between the two sample groups that is not related to coffee productivity is presented in table 3.

Calculated F-value for the assumption of variance is 9.660 with probability (Sig.) of 0.004 for the comparison between the productivity of coffee plant obtained by the GAP FS farmers and Non-GAP FS farmers. As the probability was (Sig.) 0.004 < 0.05 then H<sub>0</sub> is rejected. This means that there is a significant difference between the coffee production obtained by the farmers who applied the GAP and

16 not. Based on the results of the data analysis, it indicates that the yield of the coffee obtained by farmers who do the GAP field school and do not involve in the GAP FS significantly higher.

**Table 3.** T-test results of comparison of productivity between farmers who have attended the Good Agriculture Practice (GAP) field school (SL GAP farmers) and did not attend the field school (Non-SL farmers) in Enrekang Regency.

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Independent Samples Test

		Productivity	
		Equal variances assumed	Equal variances not assumed
Levene's Test for Equality of Variances	F	9.660	
	Sig.	.004	
t-test for Equality of Means	t	7.389	7.389
	df	28	18.976
	Sig. (2-tailed)	.000	.000
	Mean Difference	251.533	251.533
	Std. Error Difference	34.042	34.042
	95% Confidence Interval of the Difference	Lower 181.802	180.277
		Upper 321.265	322.790

#### 4. Discussion

Based on observations and interviews, the level of application of Arabica coffee GAP in the three districts of study location was still relatively low for cultivation aspect at only 25% compared to other aspects of harvest and post-harvest aspects. The cultivation aspect is the most important aspect that influences the level of Arabica coffee production. Starting from determining the variety, spacing, planting hole size, the time the hole was made before planting, shade plants, type of fertilizer, fertilizer dosage, fertilization method, type of pruning, pruning time, sanitation activities, and pest and disease control.

The dominant variety used by farmers of S795 line varieties and local Arabica with consideration that the variety is very suitable to the state of the location and its production is maximum and leaf rust attack on this variety is smaller than other varieties. Local Arabica varieties are varieties that are used by farmers for generations or self-breeding from previous plantations or coffee plantations in the vicinity which are difficult to identify the original varieties. However, the results of direct identification of local Arabica varieties are closer to Catimor varieties, but there are no supporting sources that confirm the local Arabica varieties are Catimor.

The use of spacing applied by respondent farmers in the study sites is very diverse but the use of spacing which is dominant is at spacing 2.5 x 2.5 m by 30% is in accordance with the regulations of the Ministry of Agriculture No.49 / Permentan / OT.104 / 4/2014. While the rest used varying planting distances starting from 2.0 x 1.5 m to 3.0 x 3.0 m spacing, the reasons for using spacing also vary greatly from the use of planting material to the type of shade used. The use of diverse planting distances is inseparable from the location and economic conditions of farmers, this is in accordance with the opinion of Hairuddin [8] states that actually there are no standard rules that apply as a whole regarding the

spacing of planting in Enrekang regency, depending on needs and other considerations such as climate conditions, soil, altitude, planting material, cultivation techniques, and economic considerations.

Practically, the use of planting hole sizes applied by farmers has approached the government's recommendation (27%). But the rest use the size of the planting hole with various considerations. According to one of respondent farmer (Mr. Awaluddin), the size of the planting hole suggested is too large, causing the soil in the seedling area to accommodate more water in the rainy season that can increase the risk of root rot in the transplanted coffee seeds. Inundation also influences physiological and biochemical processes including respiration, root permeability, water and nutrient absorption, N. Inundation causes root death at a certain depth and this will stimulate the formation of adventitious roots in parts near the soil surface in plants that are resistant to inundation. Root death is the cause of N deficiency and physiological drought stress [9].

For the indicator of time for the preparation of the planting hole before planting, only 7% of all respondent that applied according to GAP. One factor affected the farmer to apply this cultivation stage is because the respondent farmers are still constrained at the time of implementation of the GAP. Hanum [10] argues that the planting hole was made 6-3 months before planting by allowing the excavated soil to pile up around the hole 2-3 months. This action aims to change the reductive atmosphere of the soil into oxidative and toxic elements that change into non-poisoning. In addition, this practice also expected to allow the moisture in the sub soil can be reduced as wet soil is preferred for fungal growth that is detrimental to the growth and development of coffee plants. Besides that, moist soil is usually more acidic and less fertile.

Types of shading trees found in the field were mostly suren trees (*Toona sureni*) instead of what suggested in GAP ie. Lamtoro (*Leucaena leucocephala*) and Dadap (*Erythrina variegata*). Farmers tend to use *Toona sureni* as a shade trees as it is considered to be more efficient for the benefit of the tree for used as animal feed and as raw material for house construction. Besides suren, clove plants are also considered by farmers as an efficient type of shade. Some farmers consider that the use of these trees (Suren and cloves) as a shade crop can increase their income. Clove plants are valued by respondents as a type of shade tree with some economic value compared to other types of shade trees. As a matter of fact, the economic value of the clove trees as shading exceeded the economic value of the coffee plants. Despite this, cloves are known as plants that are greedy for nutrients and will also experience leaf senescence in certain season. Consequently, coffee plants can be exposed to excessive radiation and can compete for nutrients that can affect the growth and production of the coffee plants. Therefore, a proper selection of shade tree and management is necessary to obtain an optimal yield.

The fertilizer dosage applied by respondent farmers in Enrekang Regency involve more than one type of fertilizer. Farmers used two types of fertilizer and mixed it between organic fertilizer and inorganic fertilizer. The method of fertilization used by respondent farmers was by direct application that is intended to facilitate work, and save labour. The disadvantage of this method is that it can also stimulate the growth of weeds and the possibility of binding certain nutrients by the soil and the higher evaporation that occurs in fertilizer. Mostly coffee farmers in the study sites practiced this kind of fertilization method which is by spreading the fertilizer directly to the surface of the land. In general, this method can be applied to plants with tight spacing, as basic fertilizers on plantations, or on raised beds. Fertilization can also be done on plants that have grown (side dress) or spread directly to plants (top dress). Usually, fertilizing is done on young plants.

According to the survey, mostly coffee farmers in Enrekang regency has applied pruning. Benefits and functions of pruning in coffee plants generally are to maintain the trees size for the ease of maintenance, form new productive branches, facilitate the entry of light and facilitate the control of pests and diseases [11]. Production and maintenance pruning were more dominant applied by respondent farmers. The age factor and crop condition are an estimation of the level of production pruning conducted. The coffee trees in the study location were classified as at productive age and has passed through pruning for shapes but rejuvenation pruning is not necessary. In general, farmers routinely carried out pruning by removing unproductive adventitious branches, cutting the water sprouts and pruning back branches, old branches that are no longer productive and branches that are attacked by

pests. This practice is expected to help the farmer to achieve the goal of crop production as affirmed by Yahmadi [12], that production pruning in coffee plants is intended to maintain the balance of crop frameworks that have been obtained through pruning forms so that productive generative growth is achieved.

Increasing productivity by implementing Good Agriculture Practice certainly cannot be separated from operational standards in applying good cultivation techniques as well. The cultivation aspect consists of several sub-aspects that are interrelated, if one aspect is not applied then there is little chance of achieving maximum production.

## 5. Conclusions

Based on the evaluation results of the application of Good Agriculture Practice (GAP) that has been carried out in Enrekang Regency, it can be concluded that the overall implementation level of GAP by the smallholder farmers of Arabica coffee in Enrekang Regency is 54%. Highest level of GAP implementation was on post-harvest aspect (77%), followed by the harvest aspect (61%). The smallholder coffee farmers had the lowest GAP level on in cultivation aspect of 24%. Farmers that did not implement the GAP had a significantly lower production compared to the farmers who have participated in GAP field schools.

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