MODEL OF INTERCROPPING MODELS FOR SMALLHOLDER COFFEE FARMERS IN TANGGAMUS REGENCY, LAMPUNG PROVINCE"

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Summary of the report

The majority of coffee plantation in Indonesia is cultivated by smallholders (96.2%), while the rest are under state and private managements namely 3.1 percent and 2.7 percent respectively (Ditjenbun, 2016). The most widely cultivated coffee in this country is Robusta with an area of 899,627 hectares (73.1%) and production of 466,492 tons (73%). The rest is Arabica coffee with respected area and production of 330,373 hectares (26.9%) and 172,919 tons (27%).

The main existing problems are low production, productivity, and quality. The low production is partly due to land conversion from coffee crops to other crops (sugarcane, fruits, oil palm, etc.). Moreover, the low productivity and quality of coffee crop are due to: (1) non-productive (young/not yet yielded or old/damage); (2) not superior seed category; (3) less implemented Good Agricultural Practices (GAPs); (4) low provision of technical production inputs (fertilizer, pesticide, etc.); (5) low extend of harvest and postharvest handling; and (6) climate change (long rainy and dry seasons).

Technically, coffee can be planted either with monoculture or polyculture patterns. In monoculture pattern, generally in large plantations, coffee crops are grown using *Leucaena glauca* and *Moghania macrophilla* as permanent and temporary shading plants respectively. Meanwhile, in polyculture pattern, apart from *Leucaena glauca* as a permanent shading plant, coffee crop can be planted with other crops such as estate crops (pepper, nutmeg, etc.) and fruit crops (orange, avocado, banana, etc.). This pattern is commonly practiced in smallholding farms.

Coffee of Tanggamus at Glance

Tanggamus is one of 13 regencies and two cities in Lampung province. This regency consists of 20 districts, 293 *pekon* (rural village), and 3 *kelurahan* (urban village). Geographically, Tanggamus regency is located between 0 to 2,115 meters above sea level, in which 40 percent of its area is hilly and mountainous (BPS, 2018). Average annual rainfall and number of rain day were about 2,000-millimeter and 130-day, respectively (BMKG, 2018).

Tanggamus regency is the second largest producing area of smallholder Robusta coffee farms in Lampung province. The proportion of area and production of smallholder coffee farms as well as number of smallholder coffee farmers in Tanggamus regency toward those of Lampung province were 26.90 percent, 26,92 percent, and 29.01 percent, respectively (Ditjenbun, 2016).

The harvesting season of coffee was generally from April to July. But sometimes it happens up to August. The initial production of coffee in April was low, continuing increase up to peak season in July. The production pattern of coffee farms depends upon altitude area, the highest the altitude farm area will delay the initial and peak harvesting coffees into June and August respectively.

Most of farmers applied semi-selected picking coffee method when at least 50 percent of its cherry groups are ripped or red color, then all of them were harvested including the yellow and green ones. The harvested coffee transported to the house and dried immediately using drying floor without selecting (put together the red, yellow, and green). The length of drying was 1-4 weeks, depends on the weather condition.

After drying, coffee was milled in order to release its peel as well as horn and husk skins to get green bean with moisture content of 18-20 percent. It is commonly identified as *kopi asalan* (random coffee). Some farmers processed coffee individually and some others processed by local processor in which every 30 kilogram processed coffee would be taken out one kilogram for processing cost. The random coffee was partially marketed to local trader, farmer's group, and KUB, while the rest is stored which is sold it in other time. In other words, farmers would sell coffee based on family needs. Overall, the problems of farmers in term of harvest and postharvest were related to weather condition (heavy rain), lack of labor, and limited availability of owned coffee mills.

In the last five years (2014-2018), the average productivity of smallholder coffee farms in the area was 600 kilogram green beans (random coffee) per hectare. Within 2017-2018, the average productivity extremely deceased more than 50 percent, namely about 200-400 kilograms per hectare. It is because of old-age coffee farms, berry borer attacks, and climate change (long wet and dry seasons).

In general, the productivity of coffee in Tanggamus initially increases of about 9.42 percent per year (2014-2016). However, in the last three years (2016-2018), the productivity in this regency decreased of around 22.54 percent annually (Figure 4). It is possibly, among others, due to climate condition. Figure 5 and Figure 6 show that the rainfall intensity and number of rainy days in Tanggamus regency quite fluctuated during the last five years (2013-2017).

The marketing channel of random coffee of farmers presented in Figure 1. It involves certain institutions such as farmer's group, local trader/collector, KUB, and PT Nestlé Indonesia. Farm gate price was IDR 19,000 to IDR 24,400 per kilogram. The extent of farm gate price depends upon the quality of coffee particularly its moisture content. Data from PT Nestlé Indonesia (Figure 8) shows that the average price from 2014 to 2018 ranging from IDR 23,603 per kilogram to IDR 26,234 per kilogram (IDR 25,025 /kg, on average).

It was noted that since June 2018, exporters (PT Olam Indonesia, PT Nedcoffee Indonesia Makmur Jaya, PT Louis Dreyfus Indonesia) have involved to which KUB was not able to sell coffee to PT Nestlé Indonesia directly. Consequently, there was uncertainty farm gate price of coffee as compared to previous time when KUB was able to sell coffee directly to PT Nestlé Indonesia

PT Nestlé Indonesia has developed some demonstration plots of intercropping model-based smallholder practices in certain areas. Those demonstration plots were also aim at introducing and implementing Good Agricultural Practices (GAPs) in coffee farms. It was observed that the number of coffee crops was quite abundant namely 1,600-2,500 plants per hectare due to tight planting space of 2 x 2 meters and 2.5 x 2.5 meters, respectively. Coffees were planted with intercropped plants and shading plants competitively, so that the production of coffee would be potentially lower than its productivity.

The existing age of coffee plants was 4-6 years, namely Somatic Embryogenesis (SE) seed derives from Indonesian Coffee and Cocoa Research Institute (ICCRI). Before distributing to farmers, seeds were collected and cared at Education and Development Farm (Edufarm) of PT Nestlé Indonesia. Farmers not only obtained seeds but also gained technical assistance from PT Nestlé Indonesia.

According to some farmers, the productivity of SE clone was unsatisfactory or lower than that of local clone. Therefore, the SE clone was alternatively topped with the local clone. It is actually required to assess the technical aspect of both clones in terms of age, production treatment, and productivity. It should be noted that; however, SE clone requires more intensive management with higher production inputs as compared to local clone.

It is necessary to maintain and to improve the advantage and disadvantage aspects of existing smallholder coffee intercropping model. Some disadvantage aspects that should be improved are planting system and planting pattern of coffee and intercropped plants. It is noted that the productivity of Robusta coffee was not only determined by the optimum number of plants but also by its planting system. Rectangular planting system with planting space of 3 x 2 meters is better comparing to square planting system with planting space of 2.5 x 2.5 meters. It is because the rectangular planting system would provide simply windy plant pollination due to hallway effect if three different types of coffee clone were planted in alternating space rows. Moreover, the extent number of coffee plants in rectangular planting system is higher about four percent than that of square planting system. Apart from that, the row space can be planted either with seasonal or perennial intercrops and thus it would be easily maintained without disturbing the existence of coffee as main crops. In addition, there are side exposure effects of sunlight to the canopy of coffee plants supporting the process of photosynthesis to which it can improve the productivity of coffee farm.

The implementation of coffee intercropping model should be determined by some aspects particularly in line with the interest of farmers, preference of consumers, occurrence of price, and adapted with

local culture as well as free as host plants for major pests and diseases. The preference of consumers and the occurrence of price should be particularly considered due to its dynamics in the area.

It is proposed coffee intercropping model with pepper, banana, avocado, and chili. It was noted that pepper and banana have been planted for a long time in Tanggamus regency. Banana is one of primary commodities in Lampung province, including Tanggamus Regency.

There are two intercropping model proposed. Both are improved intercropping model based on farmer practices and modified it in line with designed model of PT Nestlé Indonesia (Table 4). They are as follows:

1. Model 1: intercropped coffee-pepper-*lamtoro*-chili with avocado as border plant. The spacing spaces are 3 x 2 meters (coffee), 6 x 4 meters (pepper and *lamtoro*/shading plant), 1 x 0.6 meters (chili), and 6 meters (avocado). The number of plants per 0.5 hectare is 600 coffees, 143 pepper and *lamtoro*(s), 910 chilies, and 43 avocadoes. Planting points for border plants are three meters from land boundary and two meters from coffee plants at east-west and north-south sides (Appendix 2).

2. Model 2: intercropped coffee-pepper-*lamtoro*-chili with banana as border plant. The spacing spaces are 3 x 2 meters (coffee), 6 x 4 meters (pepper and *lamtoro*/shading plant), 1 x 0.6 meters (chili), and 6 meters (banana). The number of plants per 0.5 hectare is 600 coffees, 143 pepper and *lamtoro*(s), 910 chilies, and 43 bananas. Planting points for border plants are three meters from land boundary and two meters from coffee plants at east-west and north-south sides

The intercropped farm profitability is calculated based on crops exists in intercropped coffee farm, namely: (1) coffee as a main crop; (2) pepper and chili as intercropped plants; (3) avocado and banana as border plants; and (4) *lamtoro*as shading plant (tree pillar for pepper plant). It encompasses each crop and cumulative crops-based intercropped calculation toward farm input-output analysis. The profitability of main coffee crop is calculated within 12 years production period, namely from the first year up to the twelfth year. It would be harvested at the third year with negative profit. The positive profit would be started at the third harvesting period annually and the seventh harvesting period cumulatively. Both profits tend to increase within consecutive harvesting period. The highest annual profitability would be obtained at the eleventh harvesting period, while the largest cumulative profitability would be gained at twelfth harvesting period.

It is calculated that the profitability of coffee at 10-12 year after planting is about IDR 18,300 per plant per year, on average. Cumulatively, the average profitability is almost four-time of annual profitability.

Overall, the ratio between benefit and cost (B/C ratio) is calculated in line with monetary terms relative to its costs expressed in discounted present values. It is summarized that the ratio between benefit and cost of intercropped coffee-pepper-chili with avocado border plant and *lamtoro* shading plant (B/C=2.27) is aggregately higher than that of intercropped coffee-pepper-chili with banana avocado border plant and *lamtoro* shading plant (B/C=1.38). The average benefit of coffee with avocado border plant is IDR 5,721,630 per year (IDR 476,802/month). Meanwhile, the average benefit of coffee with banana border plant is IDR 2,028,319 per year (IDR169,027 /month). This indicates that avocado border plant is much more profitable than banana border plant in intercropping coffee farm.

It is required good preparation in implementing the planed model includes planting of temporary shading plant (*Moghania macropylla* and permanent shading plant (*Leucaena glauca*PG 79 clone) one year before planting coffee. Apart from that, coffee seeds must perform technically prepared and environmentally adapted criteria, namely 6-9 months (age), ≥ 50 centimeters (height), and resistant to nematode (such as using rootstock from BP 308 clone).

It is suggested to apply 2-3 different Robusta coffee clones planted within alternating placement between planting rows at the same area.The planting schedule of seasonal intercropped plant (chili) should be carried out during the less activity of maintaining coffee crops. I addition, planting chili should be rotated with other seasonal crops such as corn and ginger to prevent pest and disease attacks.