Perceived Impact of Oil Palm Plantation on Agriculture and Environment

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Abstract. Increased demand for vegetable oil and energy has led the global production of palm oil to increase substantially. However, the expansion of oil palm is often criticized because of its impact on the environment and natural resources. The present study aimed to assess the villagers' perception of the impact of oil palm plantation on agriculture and the environment. Data collection was done in Tanggetada sub-district in Southeast Sulawesi. Ninety-one residents from three villages in the plantation zone were selected as respondents. Data were collected through the questionnaire-based interview and Key Informant Interview (KII) methods and were analyzed qualitatively using descriptive statistics. Research results showed that villagers had perceived some impact of the plantation on the agriculture, namely, improved skills in oil palm cultivation, decreased farm size, increased pest and disease occurrence on cocoa plants, and increased market demand for farm produce. The plantation was perceived to have led to increased soil erosion, increased frequency and severity of flooding, and decreased surface water quality. Plantation was perceived to have led to increased temperature but only when the oil palm trees were still young. Strict implementation of government regulation in the establishment and in the operational activities of the plantation can help minimize its adverse impact on the environment and community livelihood.

1. Introduction

Palm oil has been the most consumed vegetable oil in the world. Increased energy demand and population growth led to increased demand for oil palm [1]. As such, in the past several decades, the global production of palm oil has doubled every 10 years. In 2018, the land area for oil palm plantation was 18.9 million hectares, and production reached 71.45 million tons. The average production is 3.214 t/ha [2]. The trend of increased demand still prevails and may lead to more expansion of the plantation.

Indonesia is the largest palm oil-producing country where oil palm production expansion has massively taken place. In 1970, the land area for oil palm plantation was 0.13 million ha and the production was 0.22 million tons, which increased to 14.05 million ha with production reaching 37.97 million tons in 2017 [3]. Initially established in Sumatera and Kalimantan, the plantation was then expanded to Papua and Sulawesi. In Southeast Sulawesi, despite not being a prioritized commodity [4], its land area and production continued to increase, reaching 71,129 ha and 99,427 tons in 2019, respectively [3]. This expansion of oil palm cultivation has become the topic of political and environmental debates. Arguments in favor of oil palm are based on its important role in promoting economic development and rural livelihoods, mitigating climate change, and providing alternative
sources of energy [5]. Arguments against it are concerned with its severe unintended impact on social, economic and environment [6].

Numerous studies had indicated that oil palm plantations have adverse impact on the environment and agriculture in the surrounding villages, such as biodiversity loss [7], deforestation [8], water and air pollution [9], increased carbon dioxide (CO2) emissions [9], greenhouse gases [10], pest and disease occurrence [11], and increased flood risk [1]. Conflicts between communities and plantation companies over the plantation’s adverse impact on the environment have also been reported [12]. However, coverage and severity of the impact may differ from one place to another. Nevertheless, information on plantations in Sulawesi is still limited. It is against this background that this study is conducted to assess the perceived environmental and agricultural impact of oil palm plantation.

2. Methodology

The field survey was conducted in Tanggetada subdistrict of Kolaka District. Data collection was done twice in three villages out of nine villages where oil palm trees were grown. The first data collection was done in September-October 2014 and the second one was carried out in September 2020. The study villages were selected based on the land size of oil palm plantation and the villagers’ ethnic diversity. In the first field survey, data were collected from 91 respondents who represented (i) partner smallholders of the company, (ii) plantation company’s casual workers, and (iii) partner smallholders and workers. A proportionally stratified random sampling method was used to select respondents from each village. Interviews based on questionnaires and Focus Group Discussions (FGDs) were used to collect data and information. Data were analyzed qualitatively using descriptive statistics.

In the second field survey, we employed Key Informant Interviews (KIIIs) to collect information about the current conditions in the area [6], [13]. The purpose of the survey was to update information from the villagers regarding agricultural and environmental impact of the plantation. While the quantitative indicators of the perceived impact were still based on the first field survey results, the second survey results were used to update the qualitative information on any impact indicators whenever necessary.

3. Results and Discussion

3.1. Socioeconomic Characteristics of Respondents

A great percentage of respondents (82.5 percent) have the age from 15 to 55 years old. Most respondents completed formal schooling (44 percent for elementary school, 37.4 percent for junior and senior high schools, and 5.5 percent for university). About 56.0 percent of respondents had family membership of four persons, and 44.0 percent had more than four persons. Concerning income sources, 56.0 percent earned a living from agriculture, 26.4 percent worked in plantation, and the remaining had various jobs. Tolakinese constituted 39.6 percent of respondents, while the remaining was from other ethnicities, namely Buginese, Balinese, Lomboknese, and Javanese. These last three ethnicities came and stayed in the area under the state-sponsored transmigration program.

3.2. Impact on Agriculture

Table 1 presents respondents’ responses regarding the impact of oil palm plantation on agriculture. Respondents perceived increased skills in oil palm agriculture, decreased farm size, higher incidence of crop pests, and decreased production of estate crops as important agricultural impacts of the oil palm plantation company. To a lesser extent, respondents also perceived decreased rice production and improved market availability for farm products. Respondents noted increased skills in oil palm agriculture as they knew about oil palm and oil palm farming practices only after the establishment of the plantation. Some of the respondents reported that the company provided them with training in oil palm farming practices. Such proper training was crucial as none of them had any experiences with oil palm farming. Some respondents stated that they had grown oil palm independently in their plots.
Table 1. Perceived impact of oil palm plantation on agriculture

| Parameter                        | Respondents (%) |
|----------------------------------|-----------------|
|                                  | No effect | Positive | Negative |
| Skill in oil palm agriculture    | 8.7       | 91.3     | 0.0       |
| Decreased farm size              | 33.3      | 0.0      | 65.9      |
| Incidence of crop pests          | 27.5      | 0.0      | 72.5      |
| Production (cocoa)               | 47.3      | 0.0      | 52.7      |
| Production (rice)                | 79.1      | 0.0      | 20.9      |
| Market for farm produce          | 73.6      | 26.4     | 0.0       |

The majority of respondents said that the plantation improved their skills in oil palm agriculture. The perceived improved skills in oil palm agriculture are understandable as oil palm was a new plant in the area. Kolaka region has been famous for several estate crops, notably clove and cocoa [14], but it was not the case with oil palm. Farmers and even most extension officers were engaged with oil palm for the first time only after the establishment of the plantation in 2005. Therefore, smallholders lacked agronomic knowledge and basic technical capacity to grow oil palm successfully. In this regard, smallholders learned that knowledge and skills from the plantation company, either directly or indirectly.

A large percentage of respondents reported declining farm size as one substantial agricultural impact of the plantation. Declining farm size was associated with two things. Firstly, villagers handed their land to the company with the returns of receiving monthly benefits. Secondly, many smallholders sold their land to other persons after realizing that the monthly benefits from the company were much lower than they expected. Transfer of land ownership to other parties was largely found in the villages where many native people lived. As a result, some villagers either had smaller farm size or no longer had land for farming. They then either worked as farm laborers or earned a living from the non-agriculture sector. The loss or reductions of smallholder land ownership were related somehow to the characteristics of development agreement between the communities and company, which was perceived to be lacking transparency and involving unequal benefit sharing. In this regard, local government should play a key role in ensuring that the plantation company provides maximum livelihood benefits to smallholders.

Over 70% of respondents perceived an increased incidence of crop pests in the cocoa plant. Increased crop pests might be related to ecosystem changes from forest to monoculture plantation which cannot support similar levels of biodiversity as forest. Monoculture oil palm plantation leads to biodiversity loss, and the use of insecticide and herbicides within the plantation leads to a reduced abundance of insects, which results in the reduction of natural enemies. Cocoa farming near the palm oil plantation will be affected by such ecosystem disturbance. Insects and mites that attack cocoa farms become more challenging to address because of the reduced number of natural enemies. Increased crop pests and reduced crop production were also reported by Obidzinski et al. [6] and Andrianto et al. [11].

The perceived increase in pest attacks and reduced cocoa production, however, must be interpreted with caution. Smallholder cocoa farming was observed to face challenges similar to that in other areas in the province, namely decreased productivity and quality of cocoa beans [15] and hence low net farm returns [16]. Besides pest and disease attacks, several responsible factors included poor farming practices, low-quality seedlings, aged plants, and lack of extension [15]. Also, the farmers who worked as casual workers in the plantation could not allocate enough time to take care of their cocoa plants. Therefore, pest attacks due to the presence of oil palm plantation might only aggravate the underlying factors leading to decreased productivity. As a result, as revealed in recent interviews with key informants, most smallholder farmers in the study area no longer take care of their cocoa farming.

Some respondents (26.4 percent) perceived increased market demand for farm produce as a positive effect of oil palm plantation. This was basically related to more short-term economic benefits offered to villagers by working in the plantation. At the same time, more people from other areas were coming to stay in the plantation villages. As a result, there emerged economic multipliers that enabled
farm produce, such as vegetables and fruits, be sold faster than before. However, the recent KIIIs reveal that plantation work is not much available now. Working hours are significantly reduced, so some workers are reported to leave the job voluntarily. For this reason, the economic multiplier of the plantation is perceived almost to disappear.

Concerning the economic multipliers, the presence of the campus of Sembilanbelas November University in the area is worth noting. The university was originally located in the capital of Kolaka District and, in the last several years had built the new campus in Tanggetada. In 2019, all university’s operational activities at the old campus in Kolaka had been moved to the new campus. Many people were then came and stayed in the area. The campus presence creates some economic opportunities for villagers and to some extent helps fill the loss of economic multipliers from the plantation company.

3.3. Impact on Environment

Table 2 shows that respondents observed several environmental impacts. About half or slightly more than half of the respondents perceived increased soil erosion, increased incidence or severity of flooding, decreased water quality, decreased seawater quality, and increased temperature. These results corroborate the findings in several studies that oil palm plantation had brought about environmental impacts [6], [11]. All these impacts were related to forest loss in their surroundings. Decreased forest cover had led to soil erosion [6], especially during the early years of the plantation when palm trees have not developed a complete canopy. Eroded soil can go to water bodies and deteriorates water quality [6]. Decreased surface water quality could also be the result of the use of mineral fertilizer, insecticides and pesticides in the plantation [17], [18]. Decreasing water quality and quantity in the areas near oil palm plantation has been reported by Sarido [19].

| Parameter                          | Respondents (%) |
|------------------------------------|-----------------|
| Increased soil erosion             | 54.9            |
| Increased incidence/severity of flooding | 59.4          |
| Decreased water quality (river)    | 56.0            |
| Decreased groundwater quality      | 9.8             |
| Decreased seawater quality         | 9.9             |
| Increased temperature              | 70.3            |

A large percentage of respondents perceived increased temperature after the establishment of the plantation. This result agrees with findings in several studies that oil palm plantation areas are warmer and drier than the forest [20]-[22]. This is because the conversion of forest to oil palm plantation modifies the microclimate [22] through amplification of the variation of diurnal temperature and an increase in the mean and maximum air temperature [23]. However, during the field visit in September 2020, key informants tended to opine that a rise in temperature due to the plantation was negligible. This result might be related to the plantation age in which young plantation is warmer than mature plantation [22]. In 2020, oil palm trees have reached maturity, and their complete canopy can absorb more sunlight and reduce air temperature in the surrounding areas. A study by Norwana et al. [13] in Sabah noted that most respondents did not perceive any increase in temperature, which might be attributed to the mature plantation and the presence of forest reserve. Nevertheless, details of the temperature difference need further study as there has also been an increase in temperature due to climate change [24]. More detailed studies on the microclimatic effect of oil palm plantation are needed to ascertain the extent to which oil palm monoculture plantation can affect temperature and other microclimatic parameters.

About 60 percent of respondents perceived an increased incidence or severity of flooding after the presence of plantation. The soil in the monoculture plantation cannot absorb perfectly rain water as the forest does, so the massive amount of water that flows to the river may cause flooding. Occurrence of flash flooding due to oil palm expansion has also been reported in Kalimantan and Papua [6]. In the
study area, in addition to monoculture plantation, respondents pointed to the widening of channel due to the taking of fill materials from the river as the main cause of the floods. Fill materials for the preparation or improvement of roads were taken from the river, making the river more widened. Respondents noted that floods sometimes brought about damages to the rice field and few other properties. During the field survey in 2020, respondents noted that floods occur more frequently, leading to reduced cultivated land size and harvest failure for rice farming. Floods also lead to declining quality of ocean water as perceived by some respondents. They perceived decreased ocean water quality from the changes in the seawater color due to the flow of suspended sediments from the river. Such flow of excess sediment and pollutants as a result of intense run-off or land erosion can have negative effects on coastal marine environment, including lowering ocean water quality [25].

4. Conclusion
The study sought to understand the perceived impact of oil palm plantation on agriculture and the environment. Study results revealed that villagers had perceived adverse impact of the plantation on the agriculture, namely, decreased farm size, increased pest and disease occurrence on cocoa plants, decreased cocoa production, and decreased rice production. The perceived positive impact included improved skills in oil palm cultivation and increased market demand for farm produce. On the environmental aspect, the plantation was perceived to have increased soil erosion, increased frequency and severity of flooding, and decreased surface water quality. Plantation was perceived to bring about increased temperature but only when plantation has not reached maturity. Government authorities and all stakeholders must ensure that the plantation company’s establishment and operation should be in line with relevant environmental, legal, management, and industry standards to attain sustainable environment and community livelihoods.

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