Potential of Agroforestry Farming System Involving Honey Bee, Coffee, and Kaliandra (*Calliandra calothyrsus*) in Cieter, West Java, Indonesia

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Abstract: Forest conversion to monoculture farming is still a common practice in Cieter, Mekarwangi Village, Sindangkerta District, Bandung Barat Regency, West Java, Indonesia. The monoculture farming system is popular because it can generate more profit than other farming systems. Meanwhile, the agroforestry farming system, which can increase economic activity and is environmentally friendly, profitable, and sustainable, is less practiced among Indonesian farmers. This study evaluated the agroforestry farming system involving kaliandra (*Calliandra calothyrsus*), coffee, and honey bee (case study at D’Bees company in Cieter, West Java). The arrangement of proper cultivation and harvesting on agroforestry of honey bee, coffee, and kaliandra indicated an increase in revenue generated from product diversification. The products that are sources of income in the agroforestry system in Cieter are biomass, coffee, and honey bee commodities, such as honey and pollen. In addition to generating income, the company can help create an environmentally friendly and sustainable farming system in the area.

1. Introduction

West Java is one of the provinces in Indonesia that has high human and natural resources. One of the highest percentages of natural resources in West Java is attributed to forestry. The forest area of West Java in 2016 reached 3,709,528.44 Ha; 147,751.85 Ha was used for forest conservation, 271,159.31 Ha was used for forest protection, 401,467.54 Ha was used for production purposes, and 2,889,149.49 Ha was used for other purposes [1]. The potencies of forests have not been fully utilized in West Java. By contrast, deforestation and forest conversion continue to occur in kaliandra forest due to D’Bees (Cieter, Mekarwangi Village, Sindangkerta District, West Bandung Regency), a corporation that produces and sells honey, bee pollen, and beekeeping equipment and offers services as their revenue stream.

Forest conversion in Cieter has been ongoing since 1998, starting from the Reformation era. The forest is mostly converted into monoculture farming land for vegetables and shrubs, such as coffee and tea plantation. A preliminary study revealed that forest converters consider monoculture farming to be a more profitable system than other agricultural systems that require strict attention. Further studies are necessary to confirm this finding. Forest conversion has already caused certain negative effects that have been felt directly by the community, especially by the farmers and beekeepers around the forest. Forest land conversion leads to landslides in the areas that were once forest areas but converted to vegetable monoculture land (figure 1). For beekeepers, especially those employed at D’Bees, the reduced kaliandra forest has decreased productivity. D’Bees has responded to this issue by proposing environmental improvement projects in cooperation with the youth organizations of Cieter. To improve the forest conditions, the cooperation is jointly committed to reforest the area using various types of trees, especially kaliandra.

**Figure 1.** Agroforestry land conversion in Cieter (From left to right (a–c). a and b. Monoculture farming practice. c. Impact of landslides in Cieter).
An examination of the conditions of the natural and social environment around D'Bees company in Cieter has found that the practice of agroforestry farming is feasible. Furthermore, agroforestry is much more environmentally friendly than monoculture farming. Agroforestry may also generate more profit and is more sustainable than the monoculture farming system [2]. Resources that can be utilized to cultivate with the agroforestry farming system around D’Bees company are honey bee, coffee, and kaliandra. This study aimed to investigate the increase in economic activity by arranging the agroforestry farming system of honey bee, coffee, and kaliandra around D’Bees company, leading to an environmentally friendly, profitable, and sustainable system. This study will show data generated from focus group discussions (FGDs) and field study/direct exploration of the research location (Cieter). The data obtained were analyzed and compared with the literature on agroforestry systems involving honey bee, coffee, and kaliandra.

2. Methodology

This research was conducted using several methods, namely, FGDs, field study, and literature review. FGDs were carried out to obtain an overview of the conditions and potential processes that can be utilized around the area of D’Bees. During the FGDs, the D’Bees company owner and experts in the fields of beekeeping and agroforestry were present. The survey was conducted at D’Bees located in Cieter, Mekarwangi Village, Sindangkerta District, West Java (figure 2). The field study was performed to obtain primary data on the natural and social environment conditions around D’Bees and determine the potential of natural resources that can be utilized in the agroforestry farming system. The field study was necessary to gain insight into the role of land conversion in the monoculture cultivation system and agroforestry. The research results were then presented descriptively and enriched with a literature review on agroforestry systems involving honey bees, coffee, and kaliandra.

3. Results and Discussion

3.1. Respondents’ Background

The community of Cieter has been a producer of vegetables and shrubs (especially for tea and coffee) since 1998. The community has grown with the land conversion of the kaliandra forest. The total respondents of this study were seven individuals who converted the kaliandra forest in Cieter into the monoculture farming system.
The highest education level of the converters was senior high school, whereas the lowest was elementary school (figure 3).

Table 1. Age and numbers of respondents

<table>
<thead>
<tr>
<th>Age</th>
<th>Number of Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>17–25</td>
<td>3</td>
</tr>
<tr>
<td>26–34</td>
<td>0</td>
</tr>
<tr>
<td>35–43</td>
<td>3</td>
</tr>
<tr>
<td>44–52</td>
<td>1</td>
</tr>
<tr>
<td>53–61</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>7</td>
</tr>
</tbody>
</table>

**Figure 2.** Education level of respondents

3.2. Community Opinions about Monoculture and Agroforestry

Table 2. Survey results

<table>
<thead>
<tr>
<th>Causes of forest conversion?</th>
<th>Disagree</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Hunt and harvest natural resources (trees)  
Manage and plant woody trees  
Combine various resources such as trees, bamboo, and honey bees  
Monoculture farming system  
Agroforestry  
Monoculture farming system  
Agroforestry  
Monoculture farming system  
Agroforestry
The survey results show that kaliandra forest land conversion occurs due to the community’s view that the monoculture farming system is much more profitable than the agroforestry farming system (figure 4). The view of the community on the agroforestry resources is limited to woody trees (figure 4). Meanwhile, the other commodities present around Cieter, such as honey bee and shrub, are not considered part of agroforestry by the community. This notion shows a lack of information about agroforestry around the community in Cieter. However, agroforestry is not limited to woody trees. Agroforestry is a farming activity that intentionally integrates trees and shrubs into crop and animal farming systems, resulting in an intensive and interactive system with environmental, economic, and social benefits [3]. By integrating many commodities, agroforestry can generate additional income compared with the monoculture farming system in the same land range [2]. Therefore, if agroforestry is practiced correctly (integrating many commodities), then profits will increase compared with the monoculture system.

In addition, the community considers the monoculture farming system to be easier and simpler to implement than the agroforestry system (figure 4). This belief stems from their concept of the cultivation and sales of their products. The community of monoculture system farmers (especially vegetable and shrub farmers) has been practicing their farming activities for a long time. These farmers can easily sell their monoculture farming products because they already know where their market is. Thus, farmers require information about the marketplace if they practice the agroforestry farming system.

The thought that the monoculture farming system is much easier and simpler to cultivate than the agroforestry farming system also comes from the problems that occur in the monoculture farming system, such as pest and disease control. The farmers in Cieter believe that pest and disease control are easy in their monoculture land because the pests and diseases are relatively the same every year, and only pesticides are employed to control such pests and diseases. However, agroforestry can lead to lower pest abundance, lesser plant damage, and profitable weed management than the monoculture farming system [4].

![Figure 3. Causes of kaliandra forest land conversion in Cieter](image-url)

The major difference between the monoculture farming system and agroforestry farming system is diversity. The monoculture farming system has lower diversity than the agroforestry farming system. The agroforestry farming system, which comprises both host and non-host plants for pests and diseases, is characterized by low pest populations and low disease incidence [5]. Meanwhile, the monoculture farming system has a larger population of pests and diseases than the agroforestry farming system because the former consists only of host plants for pests and diseases [5]. In summary, the low damage from pests and diseases in agroforestry results from the minimum availability of resources (food) for pest and disease development.
3.3. Cooperation of D’Bees Company and the Youth Organization of Cieter

The cooperation between D’Bees and the youth organization of Cieter has resulted in a resolution agreed by the surrounding community not to commit illegal logging on trees in Cieter. In addition, farmers are encouraged to plant many species of trees, especially kaliandra, to transform Cieter into how it was before kaliandra forest land conversion. The cooperation between D’Bees company and the youth organization of Cieter is not only geared toward land restoration but also into creating economic profit for both D’Bees company and youth organization of Cieter.

D’Bees company empowers the youth organization of Cieter to enable them to perform beekeeping independently (figure 5). In addition to providing knowledge about beekeeping techniques, D’Bees company supports the availability of facilities and infrastructure for honey bee cultivation (figure 5). The company also provides the market for the youth organization of Cieter by purchasing their beekeeping product, which is currently limited to honey (figure 5).

Figure 4. Benefits of the collaboration between the youth organization of Cieter and D’Bees company

3.4. Potential Analysis of the Agroforestry System

Existing agricultural business activities in Cieter involve the monoculture farming system. The various types of forest products of West Java include honey bee products, mushrooms, woods, bamboo, and natural silk [6]. By contrast, the products of Cieter are honey bees and woody species, such as kaliandra. In terms of the agroforestry system, the commodities that are present in Cieter and can be integrated are honey bee, coffee, and kaliandra.

Honey bee has a high economic value and potential to be developed in the agroforestry system in Cieter. D’Bees company, which ventured into beekeeping in 1992, experienced a time when honey bee productivity peaked. On the basis of D’Bees company’s data, before forest land conversion occurred in 1998, the harvest could reach 1000–2000 kg/year due to all the honey bee colonies managed by D’Bees (usually around 70 colonies via a super hive) (figure 6). The super hive used by D’Bees company reached five hive levels in 1992–1998. After forest land conversion, the harvest decreased to 100–200 kg/year, which was only 10% of production when forest land conversion did not occur (figure 6). The reduced forest land, especially kaliandra, decreased the feed availability of honey bees. The forest land area needed by a honey bee colony should at least reach 2 ha of kaliandra forest land in Cieter [7]. D’Bees company responded to this situation by harvesting honey bees only when kaliandra was in its blooming season. As long as feed for honey bees is available throughout the year, then harvesting can be done once a week.

Figure 5. Honey production at D’Bees company from 70 honey bee colonies
Coffee has become a trend in Citer especially around D’Bees company’s beekeeping area despite repeated landslide incidents in the area. The species of coffee planted in Citer include *Coffea arabica* and *C. robusta*. The amount of coffee produced in Citer varies from 1 ton/ha to 2 ton/ha. Coffee flowers produce both nectar and pollen, which honey bees consume. Therefore, cultivating coffee and honey bee products around the same area may provide honey bees with feed source plants and increase coffee pollinator communities. Moreover, the presence of honey bees in coffee plantations can lead to high coffee production by raising the pollination rate [8]. Coffee plantations can provide nectar and pollen continuously because the coffee flowering time in Citer lasts the entire year (figure 7). To date, Kaliandra in Citer has been utilized as a feed source and nectar provider of honey bees. In the agroforestry system, kialiandra may also be utilized as biomass resource and shading tree for coffee. Kaliandra’s flowering time in Citer changes yearly; it can happen between January and June or November and April, but it generally occurs from December to May (figure 7).

**Figure 6.** Kaliandra and coffee flowering times in Citer

The flowering time is affected by irregular climate changes. The agroforestry system in Citer can be practiced by combining honey bee, coffee, and kialiandra into a single system. In 1992–1998, the 70 colonies of honey bees of D’Bees company were fed by 2 ha of kialiandra forest land [7], which indicated that the total area being used by D’Bees company from 1992 to 1998 was around 140 ha. This total area, which has already been converted, can be used as an area for agroforestry involving honey bee, coffee, and kialiandra.

### 3.5. Agroforestry Involving Honey Bee, Coffee, and Kaliandra

Certain requirements must be met to combine honey bee, coffee, and kialiandra into a single agroforestry system. Honey bee has been utilized in beekeeping in Citer since 1982, and Citer is a suitable location for successful beekeeping. Meanwhile, coffee is a plant that is a current trend in Citer. Mekarwangi Village of Citer was recognized as one of the best coffee producers in West Java at the Speciality Coffee Association of America Expo 2016 in terms of quality and characteristics [9]. Kaliandra is a tree species that has been planted in Citer long before 1990. The growth requirements of honey bee, coffee, and kialiandra are provided in Citer.

Measured spacing is a technique that is not used in kialiandra forests. Thus, we assumed that the spacing between trees was 2 m \( \times \) 1 m, resulting in 5000 trees/ha. Kaliandra produces 42 mL of nectar per tree per day [10]. Well-managed kialiandra can provide 5–20 m\(^3\) kialiandra per hectare in the first harvest (1-year-old kialiandra) and 35–65 m\(^3\) for kialiandra that is annually harvested in 20 years [11].

### 4. Conclusions

By arranging proper cultivation and harvesting practices in relation to agroforestry among honey bee, coffee, and kialiandra, revenues generated from the addition of product types may increase. The products that can be the sources of income in the agroforestry system at D’Bees company are biomass, coffee, and honey bee products (e.g., honey and pollen). The company can gain additional income from these products, as well as create an environmentally friendly and sustainable farming system. Future studies should assess how much honey bee, coffee, and kialiandra products can be harvested in the area.

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