Policy advocation: the potential role of independent smallholding oil palm plantation in biodiversity conservation

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Policy advocation: the potential role of independent smallholding oil palm plantation in biodiversity conservation

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Abstract. Despite the frequent reports of large-scale oil palm plantations' lack of attention to biodiversity conservation, there is a paucity of reporting on smallholding plantation contributions in this regard. Yet, vegetation heterogeneity supports richer biodiversity, and this is a characteristic of independent smallholdings. This paper discusses the potential role of independent smallholding oil palm plantations in biodiversity conservation with respect to butterfly and earthworms. Data were collected on four large-scale and four smallholding plantations in the Districts of Kampar, Pelalawan, Kuantan, Singingi and Siak of Riau Province, using a time-survey method for butterflies and hand-sorting method for earthworms. The research also used direct interview with oil palm owners and community members to assess the environmental value of independent smallholdings. Results showed that independent smallholdings were considered to be ecologically-friendly, where most have been shown to support higher species richness of butterfly and higher density of earthworms, than large-scale plantations, due to the irregular maintenance practices, as well as proximity to secondary forest and rubber plantations. It can be concluded that the informed management of independent smallholding oil palm plantations could effectively support biodiversity conservation.

1. Introduction

Although the production of palm oil in Indonesia is mainly derived from large-scale plantations, but in fact, the current expansion and share production of smallholding oil palm plantations are increasing in numbers and shows higher annual rates of expansion than large-scale plantations [1], thus likely to dominate the production of palm oil in the future, as also observed by [2] and [3]. Despite many problem of unclear status of forest and land tenure [4];[5], data estimation in Riau Province alone, as the largest province with oil palm plantations and the largest palm oil production in Indonesia, shows that the coverage of smallholding oil palm plantations in 2016 is estimated to amount to 1,441,705 ha, and even its productions (3,852,473 tonnes) exceed that of large-scale productions at 3,591,262 tons [6].

Such growth is also apparent by the occurrence of many land use conversions to oil palm plantations as seen by [7]. This corresponds with the findings by, [8], [9]) and [10] that smallholding oil palm plantation has the potential to positively contribute to earnings and household poverty for local and regional development ([11]; [12]; and [13]).

There are several types of smallholding schemes in oil palm plantations; however, one that is of interest in this research is the independent smallholdings. Various literatures ([14]; and [15]) have noted that the independent smallholding practices are more ecologically-sound. Independent smallholders are often limited by capital for maintenance and expenses including weed control and fertilization, hence tend to irregularly manage their oil palm stands. Such practice has caused the growth of shrubs around the stands which provide habitats for various species. Habitat heterogeneity have been emphasize by various researchers ([16]; [17]; [18]; [19]; and [20]) as a significant determinant factor for species richness. Furthermore, the lack of capital to invest on fertilizer, has push the smallholders to use the most efficient and cheap means of fertilizer, i.e., organic fertilizer, which will have positive impacts on soil quality. With such interesting ecologically-friendly form of limited management, and the continuously increasing number of independent smallholdings, it is thus important to identify the conservation importance of independent smallholding oil palm plantations on biodiversity.

On the contrary to their rapid growth and many biodiversity studies on large-scale oil palm plantations, there has been paucity on studies of the impacts of independent smallholdings, especially on biodiversity. [21], in their analysis, found only one study that has been attributed to address the differences in species richness and community composition between smallholdings and large-scales plantations. Such study was conducted by [18] who find that on average, smallholdings with mixed-age stands hold higher bird species richness than large-scale plantation with uniform age structure.

According to European Environment Agency (2007 *in* [22]), good indicators of biodiversity changes should portray the following qualities: (1) policy and biodiversity relevant; (2) can measure progress towards target; (3) based on well-founded methodology; (4) broad acceptance and intelligibility; (5) data regularly collected; (7) cause-effect relationship achievable and quantifiable; (8) spatial coverage; (9) country comparison possible; and (10) sensitivity towards change. Birds and butterflies are the most common species to be used to detect biodiversity changes. For comparison purpose with [18] research on birds (vertebrate) in smallholding oil palm plantations, and as additional scientific information on the role of smallholdings on biodiversity, this research will use invertebrate species (i.e., butterfly and earthworms) to assess biodiversity.

Butterflies were surveyed because they frequently serve as flagship taxa and can be rapidly monitored in the field ([23]; and [24]). At variance with most other groups of insects, butterflies are well documented, well characterized [25], very common, and charismatic [26]. Furthermore, they are sensitive to land changes, intensification or abandonment [22], making them a good biological indicators of biodiversity and degradation of ecosystem services. In the same line, earthworms are often classically used to assess soil quality ([27]; [28]; and [29]) because they are an important part of the soil system, frequently found, easy to collect, and easy to identify [27].

2. Methodology

2.1. Study area

The research was carried out in Riau Province, Indonesia from March-April 2016 at four large-scale oil palm plantations and four independent smallholdings. Each company and its closest independent smallholdings will be categorized as Sites 1-4. The study sites were in PT. Kebun Pantai Raja (KPR) in Kampar District (Site 1), PT Surya Agrolika Reksa (SAR) in Kuantan Singingi District (Site 2), PT Mitra Unggul Pusaka (MUP) in Pelalawan District (Site 3), and PT Ivo Mas Tunggal (IMT) in Siak District (Site 4). The large-scale study sites were further classified into youngest oil palm stands and oldest oil palm stands for each company (age of oil palm stands varied for each company depending on time of the planting).

2.2. Data collection and analysis

Field data were collected using time survey for butterfly to determine the species richness, hand-sorting method to assess the density of earthworms, and direct interview with the local people including

smallholders to gain insights into their perceptions on the impact of smallholding oil palm plantation on biodiversity.

2.3. Time Survey

Data on butterfly species were gathered using time survey method, in which the observation plot is not limited by distance/a certain area, but by length of observation time (minutes). Observations were made on each transect for each land cover type and were conducted in three repetitions in the morning when the air was already warm (at 08.00-11.00 GMT). The species richness of butterflies in both plantations was calculated using Species Richness Index (D_{mg}) [30] of D_{mg} = (S-1)/ln (N), where D_{mg} = Species Richness Index; S= Total number of species; N=Total number of individuals.

2.4. Hand-sorting

Data collection for earthworms were conducted by establishing five plots of size 1m x 1m randomly (modified method of [31]). Hand sorting method was conducted to determine the species and abundance of earthworms by digging a hole in the soil with a total area of 25 cm x 25 cm and depth of 30 cm on each plot using a hoe. Data collected comprised of the number of worms and cocoon (ova), pH, C-org and soil texture. Soil samples were taken from each hole and were put in specimen plastic. The samples were then analyzed in the Laboratory of Soil Science, Faculty of Agriculture IPB. Data were documented on a tally sheet.

2.5. Interview

Interviews were conducted to obtain information about the public perception of the impacts of smallholding oil palm plantations on the environment especially related to the provision of wildlife habitats, as well as on the management practices. The sampling technique used was accidental sampling (convenience sampling), because the total population under studied was unknown. This technique selected respondents by coincidence, i.e., anyone who by chance met with the researcher and the respondents meet the criteria as data source, that is, those who know the conditions before and after the development of smallholding oil palm plantations. Total respondents per site ranged from 21-52 people.

3. Results and discussions

3.1. Butterfly species richness

Species richness of butterflies in both large-scale and smallholding oil palm plantations are tabulated in table 1. The total number of species found within the study sites ranged between 18-34 species, with some overlapping species within the different site classification.

Table 1. Butterfly species richness in each study site

No	Study Sites	Index	Large-scale Youngest Growth	Large-scale Oldest Growth	Independent Smallholdings
1	Site 1	S	8	8	11
		D_{mg}	2.65	2.92	2.97
2	Site 2	S	17	11	18
		D_{mg}	3.89	2.66	4.52
3	Site 3	S	7	9	18
		D_{mg}	1.76	2.14	4.58
4	Site 4	S	12	9	18
		D_{mg}	2.70	2.43	4.74

The number of butterfly species that were found at Site 1 was 18 species consisted of three families: Papilionidae (1 species), Nymphalidae (14 species), and Pieridae (3 species). Table 1 showed that the highest number and highest species richness were observed in the independent smallholding, while the

lowest was found in the large-scale youngest growth. The high species richness in the smallholding plantation was also attributed to the fact that it is located adjacent to secondary forest.

Based on observations at Site 2, the total number of species found was 34 species comprised of four families: Papilionidae (3 types), Nymphalidae (23 species), Pieridae (7 species), and Hesperidae (1 species). The highest number of butterfly species was found in independent smallholdings and the lowest in the large-scale oldest growth. Such high species richness was possible due to the presence of various flowering undergrowth as well as the presence of pond-like water pool.

Site 3 is home for 27 butterfly species consisted of four families: Papilionidae (five species), Nymphalidae (14 species), Pieridae (five species), and Lycanidae (3 species). Results on Site 3 also indicated that independent smallholding provided better species richness of butterfly, while the lowest value was obtained from large-scale youngest growth. As for Site 4, with 26 species of five families: Papilionidae (1 species), Nymphalidae (17 species), Pieridae (5 species), Lycanidae (2 species) and Hesperidae (1 species), similar results were obtained, in that independent smallholdings also bear the highest number of species, while the lowest was found in large-scale oldest growth.

At all sites, the local people agreed that independent smallholding oil palm plantations provided home for various species, not just butterflies. The range of good perceptions were between 80.00% and 94.40% at all four sites. These were based on their daily observation around the smallholding area. The respondents noted several species of birds, mammals, as well as butterflies.

3.2. Earthworm Density

Density and soil texture found on each study sites were tabulated in table 2.

Table 2. Earthworm density in each study site

Sites	Classification	Parameter			Density (ind/m^2)
		pH	C-org (%)	Texture	
Site 1	YG	3.82	3.22	Clay loam	23.04
	OG	4.37	5.80	Sandy-Clay-Loam	7.04
	IS	3.54	4.51	Clay loam	18.88
Site 2	YG	3.90	4.91	Loam	21.12
	OG	4.13	1.69	Sandy-Clay-Loam	24.32
	IS	3.96	1.69	Sandy-Clay-Loam	36.8
Site 3	YG	4.16	1.12	Sandy-Clay-Loam	14.72
	OG	4.18	1.12	Sandy-Clay-Loam	0.64
	IS	4.22	0.96	Sandy-Clay-Loam	12.16
Site 4	YG	4.12	1.21	Silty-Clay-Loam	26.88
	OG	4.56	3.01	Silty-Clay-Loam	17.92
	IS	4.35	1.85	Loam Sandy	40.96

Note: YG = Large-scale youngest growth; OG = Large-scale oldest growth; IS=Independent smallholdings

The highest population density of earthworms in Site 1 and Site 3 were found in large-scale youngest growth, followed closely by independent smallholdings, while independent smallholdings obtained the highest earthworm population density on Site 2 and 4.

3.3. Independent Smallholder Management Practice

Contrary to the large-scale plantations which manage their plantation with regular weeding, pruning and fertilizing application, the smallholders were often conduct irregular maintenance of their oil palm stands. The smallholders stated the lack of capital to invest for labour as well as fertilizers. As a consequence, the use of inorganic fertilizer was often replaced by inorganic fertilizers. Even some of the smallholders were trying new ways of using cow's urine as organic fertilizer. Whereas for other management practices such as pruning, weeding, pesticides spraying and land management were conducted as often as once a year.

3.4. Importance of Vegetation Variations for Butterfly Conservation

Overall, oil palm plantations managed by companies (large-scale) tent to show lower species richness of butterfly than those found in independent smallholdings. Large-scale plantations practiced regular and intensive maintenance to ensure that the oil palm stands were free from weeds in order to achieve good harvest and high production. On the contrary, independent smallholders practiced irregular management due to limited capital to invest in maintenance. Growth of shrubs and flowering undergrowth within independent smallholdings were largely due to the fact that the oil palm stands undergo irregular clearance from weeds and often stands were left alone. The independent smallholders usually practiced pruning once a year; hence the oil palm canopy inhibited the sunlight to reach groundcover, and stimulated the emergence of undergrowth. Both shrubs and undergrowth provided fodders for butterflies. [32] and [33] states that butterflies are very dependent on the presence of feed crops, so the number and kind of feed will affect the reproductive ability of butterflies.

Apart from the irregular management practices, most of the independent smallholdings were located in close proximity to secondary forest, rubber plantations and water pool, which provided habitat variations for butterflies. This research confirmed the findings of [34], and [35] that, increase number of different habitats can lead to an increase in species diversity.

3.5. Significance of Green Manure Application for Oil Palm Stands

Results of the research showed that overall, independent smallholdings provide better habitat for the earthworm than large-scale plantations. The abundance of earthworms is strongly influenced by soil texture, pH and organic matter content in addition to land management practices [36]. These factors affected earthworms by influencing the availability of food, changing soil texture and pH. The intensive use of chemical fertilization in large-scale plantations have reduced the density of earthworms, while on the contrary, the use of organic fertilizer by the smallholders have resulted in a higher number of earthworms. [37] argues that too much inorganic fertilizer and pesticides can cause the soil to become more acidic. The soil pH in the study sites were indeed rather acidic (see table 2). Such case might provide explanation as to the reason why large-scale oldest growth plantations harbored least number of earthworms, because it is the most intensively fertilized. Most earthworm losses were caused by intensive tillage [38].

According to [31], the availability of feed, both type and quantity of vegetation in a habitat, is a decisive factor in determining earthworm species diversity and population density. The presence of vegetations was related to the availability of organic material as food sources for the earthworms, because earthworms are categorized as sarcophagus. This explained why independent smallholdings harbored higher density of earthworms.

3.6. Potential of Smallholding Oil Palm Plantation for Biodiversity Conservation

The origin of independent smallholding lands which mostly came from transmigration scheme and indigenous sold land were often located in close proximity to secondary forest and rubber plantations since most of the indigenous people land were previously rubber plantations prior to conversion to oil palms. Such locations provided additional habitat variations for butterflies, allowing a higher number of species richness. The current management practice of independent smallholdings also provides the means for a more ecologically sound practices. Lack of capital for smallholders actually provided the

bases for the use of cheap readily available local resources, such as the use of cattle urine as alternative fertilizer. According to [39], feces and urine of cattle provides several advantages: relatively cheap even free, easily obtain, contain nutrients required by plants, easy and cheap to apply, hence cattle feces and urine are good fertilizer for oil palm plantation, especially in areas where the Use of local resources would also ensure the sustainability of income generating activities. Furthermore, research by [40] found that the production of oil palm by-products such as palm leaves, palm fronds, palm mud and palm kernel can be used as fodder for sheep and beef cattle. Integration of oil palm and livestock mainly cattle, is a great potential to be developed in Riau Province, for the efficient use of palm oil by products.

4. Conclusions

Smallholding oil palm plantations tend to be overlooked by those interested in biodiversity conservation. The current independent smallholding management proofed to be a blessing in disguise, since the lack of capital to apply regular maintenance to the stands, have resulted in a more ecologically sound management practice. This research confirmed the positive role of independent smallholding oil palm plantations on butterfly conservation due to higher vegetation variation, and higher soil quality due to application of organic fertilizer. It can be concluded from this research that the informed management of independent smallholding oil palm plantations could effectively support biodiversity conservation. Therefore, more policy advocation for supportive positive role of smallholding oil palm plantation in biodiversity conservation is required.

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