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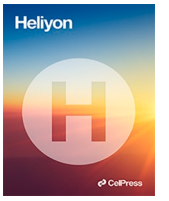

Social-life cycle assessment of oil palm plantation smallholders in Bengkulu province, Indonesia

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ABSTRACT

Smallholders are often seen as a weak point in the development of oil palm plantation production. The quality and yield of their production are considered low according to world market standards; the continuity of their production is irregular; and finally, improving the welfare of farmers is difficult to achieve. However, smallholder plantations have an important and strategic role in achieving sustainable development. This study aims to assess the social life cycle assessment of smallholder oil palm plantations in Bengkulu Province by involving stakeholders consisting of workers, local communities, farm owners, and value chain actors. A total of 600 respondents were selected using quota sampling and interviewed using a structured questionnaire. Data analysis was conducted using social-life cycle assessment, involving various social issues and relevant social indicators for each stakeholder. The findings in our research show that smallholder oil palm plantations still do not meet the minimum wage for workers, and the equipment used by workers is still very minimal in terms of security and safety guarantees. The price of palm oil continues to fluctuate, and plantation policies are constantly changing, making it difficult for oil palm owners to meet the standards and various rules that are set for managing oil palm plantations. In addition, oil palm plantations are no longer a guarantee for the fulfillment of food security conditions for household owners, workers, communities, and actors involved in the oil palm institutional chain. Our finding is that, surprisingly, there is a low level of commitment by smallholders and the government to sustainability in oil palm plantations. The Indonesian Sustainable Palm Oil and Roundtable on Sustainable Palm Oil as standards for sustainable oil palm plantations, as well as global standards for oil palm plantations to demonstrate environmentally friendly production processes, have not been able to compel smallholders to implement sustainable development in oil palm. Various policies formulated by the Indonesian government are perceived to have not addressed the core issues faced by small-scale farmers. Policies supporting small-scale farmers, particularly those related to increasing productivity, fostering and monitoring the environmental management of palm oil plantation activities, and ensuring ownership of plantation, are necessary for the achievement of sustainable smallholder palm oil plantation development.

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1. Introduction

Abbreviations

BUMDes	Village-owned Enterprise (Badan Usaha Milik Desa)
CPO	Crude Palm Oil
FFB	Fresh Fruit Bunch
Ha	Hectare (unit of area)
IDR	Indonesia Rupiah (Currency of Indonesia)
ISPO	Indonesian Sustainable Palm Oil
LCA	Life Cycle Assessment
NGO	Non Governmental Organization
PRP	Performance Reference Points
PSIA	Product Social Impact Assessment
RSPO	Roundtable on Sustainable Palm Oil
S-LCA	Social-life Cycle Assessment
S-LCI	Social-life Cycle Inventory
S-LCIA	Social-life Cycle Impact Assessment
SSH	Sampled Smallholder
USD	United States Dollar
WEF	World Economic Forum
WWF	World Wild Fund

According to the findings of a study conducted by Ref. [1], it can be inferred that plantations play a significant role as a sub-sector within the Indonesian economy. Specifically, in 2019, plantations contributed approximately 3.27% to the country's gross domestic product in 2019. In total, plantation exports amounted to $25.38 billion, with palm oil and its derivatives making the largest contribution. Even [2] reported that the 20.67% increase in manufactured exports was due to an increase in the palm oil sector. There is a significant amount of evidence indicating that the expansion of oil palm cultivation into impoverished and remote areas lifts those areas out of poverty and facilitate their transition into thriving hubs of regional economic development. The distribution of oil palm, which span across 26 out of 34 provinces, has emerged as a significant contributor to sustainable economic growth and village development. Particularly, it has served a crucial role in alleviating poverty in rural areas.

Indonesia's plantation area is still potentially wide open for oil palm plantations. The oil palm plantations located in Indonesia consist of several types based on land area. Companies with a land area of fewer than 25 ha are owned by the community and are known as smallholders. There are also medium- and large-scale companies that are usually both state-owned and privately owned, both national and foreign [3]. Additionally, there exist community plantations characterized by a multitude of very small gardens. These smallholding plantations are generally managed by farmers as owners and their families. At present, approximately 40% of oil palm plantations in Indonesia are managed by small-scale farmers [4]. Due to the involvement of impoverished farming families in the palm oil plantation development program, this practice is considered an example of inclusive development and one of the most successful poverty alleviation programs in rural areas [5]. According to Ref. [6], smallholder oil palm plantations are now a critical component of the global palm oil supply chain, with approximately 3 million smallholder oil palm plantations producing around 4 million tons of palm oil. Farmers typically exhibit limited educational background, thereby encountering challenges in effectively managing their agricultural businesses.

Despite their strategic importance to the national economy, smallholder oil palm plantations, in particular, have a negative impact on society, particularly in terms of environmental damage and social conflict. This negative impact has led to the rejection of its development by various groups in Indonesia. Various parties demand that oil palm plantations be developed sustainably so that they do not have a negative impact on the community. Sustainable oil palm plantations exemplify the concept of sustainable agriculture, namely an agricultural system that is oriented toward economic, social, and ecological benefits. The implementation of ISPO and RSPO standards in oil palm plantations addressed these objectives. However, so far, there are still many unsustainable plantations, so the negative impacts of oil palm plantations are still being felt in various regions. The haze disaster because of land fires in oil palm plantation areas, the use of child labor, land conflicts, and the low welfare of the workforce are implications of unsustainable plantations [7,8].

The establishment of oil palm plantations has an impact on social change in the community. The education and health levels of local communities are improving; school dropout rates are decreasing; and nutrition intake for children can be fulfilled. However, in addition to the positive side for the socio-economic community, the development of oil palm plantations also has a negative impact. This change can be seen in the loss of dignity among local institutions (traditional institutions) in local communities. People think more pragmatically and hedonistically, and their ways of life no longer refer to local cultural customs. Conflicts and problems may arise due to different levels of economic access between local communities and migrants, as well as between communities and large plantations [9,10].

The Social Life Cycle Assessment (S-LCA) is a novel methodology for addressing social impacts across the product's life cycle. Like environmental LCA, S-LCA follows a standardize framework with four steps: goal and scope definition, social life cycle inventory analysis (S-LCI), social-life cycle impact assessment (S-LCIA), and interpretation [11]. This technique attempts to assess the social impact of a product or service, where social impact is primarily understood as the impact on human resources, human well-being, cultural heritage, and social behaviour [12]. S-LCA research has developed significantly worldwide, and the majority of S-LCA studies are conducted to evaluate the social and socio-economic aspects of products and their potential impacts along their life cycle, from extraction and processing of raw materials to final disposal, passing through manufacturing, distribution, use, reuse, maintenance, and recycling [13–16]. Nevertheless, it remains challenging to find S-LCA studies conducted in the agricultural or plantation sector, particularly in the case of smallholder palm oil plantations [17–19].

This work is the first attempt at S-LCA in the Indonesian plantation sector, especially for smallholders. It demonstrates the social risks and positive social impacts of this field that are not adequately addressed in the scientific literature. Research on life cycle assessment (LCA) has begun to develop in Indonesia [20–25], but no S-LCA has been reported on smallholder oil palm plantations. What is observed in this study is not only the social issue of smallholder palm oil plantations but also the comprehensive assessment of the social impacts of smallholder palm oil plantations by involving various stakeholders. This research will undoubtedly make a significant contribution to assessing the social impacts of smallholder palm oil plantations because no similar studies have been conducted or found that utilize S-LCA as the methodology. Most of the research on the social impacts of oil palm plantations in Indonesia is conducted on state and private plantations [26–29]. There is still limited research that focuses on smallholder oil palm plantations [30]. The data collected to assess the social impact of oil palm plantations is only collected from communities living around the plantations. It is very important to analyze the social impacts of smallholder oil palm plantations comprehensively by involving various stakeholder groups, as presented in the S-LCA. The Social Life Cycle Assessment method is used to assess the positive or negative impacts and potential impacts of the social aspects of the product on relevant stakeholders, which can provide information to decision makers in order to improve social conditions in oil palm plantations.

So far, the methods used in S-LCA have gaps due to the lack of standardized methodologies and are not very applicable to oil palm plantations. Most methods [e.g. [31, 32, 33, 34, 35], etc.] measure product impact without identifying hotspots or predicting improvements. Some methods [e.g. [36, 35, 17]] were able to assess improvement, but the results were based on arbitrary criteria and couldn't be used to draw any conclusions. Furthermore, assessing social impacts on a functional basis has been problematic because it is difficult to relate intangible social impacts to physical flows [37–39]. Adopt a nominal baseline approach [39,40]. Therefore, benchmarking to improve the sustainability of society is a challenge.

Bengkulu province is one of the regions in Indonesia that has the highest production of oil palm. As the second poorest province on the island of Sumatra, oil palm is an outstanding plantation commodity and plays a very important role for the regional economy as well as society. However, the development of the agricultural sector, especially the oil palm crops in this area, is not optimal for improving the welfare of the community. It is caused by the still-occurring land conflict between smallholders and private oil palm plantations [41], technology and innovation that are still limited to smallholder plantations, a lack of activity to increase the value added of the products, low levels of education among the farmers, low productivity, and various other problems [42].

The goal of this study was to evaluate the social performance of smallholder oil palm plantations in Bengkulu, Indonesia, and identify social hotspots among stakeholders involved in the production of fresh fruit bunches. The system boundaries and the

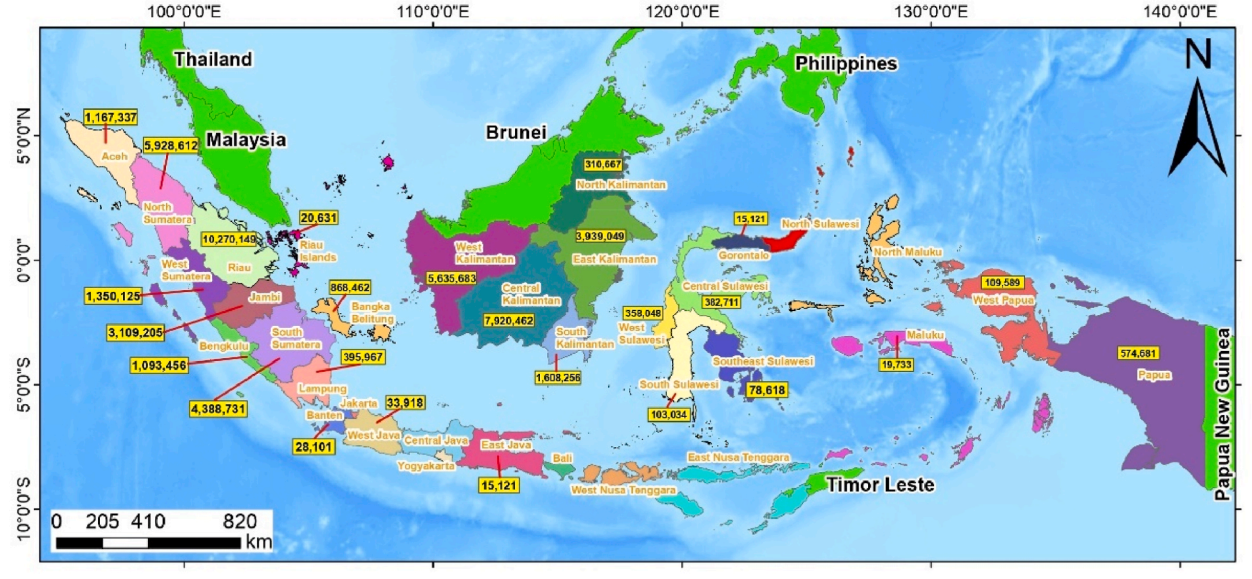

Fig. 1. Map of distribution of palm oil production in Indonesia (tonnes), 2021.
Data source: [51].

completeness of the indicators utilized to assess the social impacts of oil palm plantations distinguished this study from other studies.

2. Oil palm plantation in Indonesia

Smallholder palm oil plantations in Indonesia have increased from 3125 ha in 1979 to over 6 million hectares in 2019, accounting for approximately 41% of the total palm oil plantations in Indonesia [43]. The categorization of smallholder palm oil production in

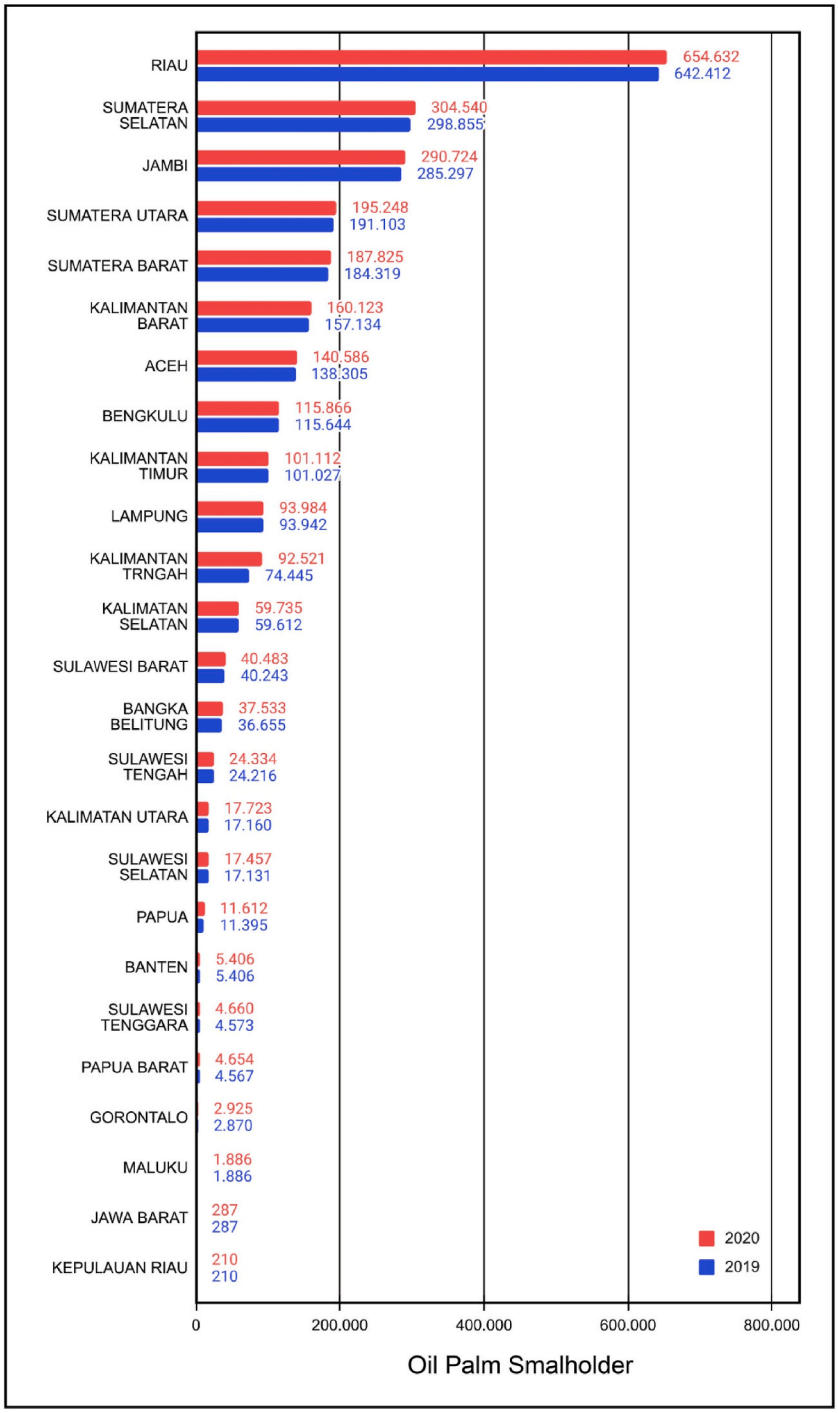

Fig. 2. Distribution of oil palm smallholder in Indonesia.
Data source: [[51]]

Indonesia typically encompasses two groups: independent farmers and plasma farmers [44]. Independent farmers manage their plantations individually, without receiving governmental assistance, which frequently results in relatively low production yields (2–3 tons per hectare). Frequently, they exhibit a deficiency in agronomic expertise, such as appropriate fertilizer dosage and harvest cycles. Additionally, limited financial resources and access to high-quality seedlings contribute to this situation [44–48].

As mentioned earlier, there are a high number of smallholders for oil palm, with the second largest land area behind major private corporations. The employment generated by smallholder farmers amounts to over 4.4 million people, or 2.5 million households. In Indonesia, the distribution of oil palm production is expanding with the development of oil palm plantations. Fig. 1 shows the distribution of oil palm plantations and the potential for palm oil production in Indonesia. The provinces of Riau, Kalimantan Tengah, Sumatra Utara, Kalimantan Barat, and Sumatra Selatan are the top five palm oil-producing provinces in Indonesia. The contribution of these five provinces reached 68.69% of Indonesia's total palm oil production, whereas sequentially these five provinces contributed 20.66%, 15.93%, 11.93%, 11.34%, and 8.83%. On the other hand, the World Economic Forum (WEF) has emphasized the significance of smallholders in the oil palm industry and their pivotal role in ensuring food security in developing countries [49]. Concerning plantations, including smallholder oil palm plantations, Law No. 39 of 2014 mentions the multifunctionality of plantations. Based on this law, plantations serve three functions: economic, ecological, and socio-cultural. The role of smallholder oil palm plantations is to improve the well-being and wealth of people by providing employment, developing responsible and sustainable plantation resources, providing a source of raw materials for downstream industries, and maintaining local wisdom and environmental sustainability. This is also reflected in the farm's organizational goals, such as promotion. The above discussion shows the importance of smallholder oil palm plantations for sustainable development [50].

The soaring demand for palm oil poses a significant challenge for countries in terms of cultivating and increasing palm oil production to adequately satisfy both local and global demand. The current focus is on expanding the plantation area to produce higher volumes of crude oil to serve the needs of the world market. The development of oil palm, either directly or indirectly, will affect the need for manpower. The amount of labor needed for oil palm can be influenced by land area, topography, climate, the age of the plant, and the type of work. Indonesia's main plantation statistics for 2021 indicate that oil palm plantations involved more than 2.5 million households in 2019 and increased to 2.6 million in 2020. This number is distributed among 25 out of the 34 provinces in Indonesia. Fig. 2 shows the distribution of oil palm smallholder in Indonesia, and indicates that oil palm plantations have emerged as a source of income for numerous households in Indonesia.

As the largest palm oil-producing country, Indonesia needs to regulate and maintain the sustainability of its palm oil industry to survive in a highly competitive global trade. Indonesia enacted a policy governing the management of oil palm in 2011, which is called the Indonesian Sustainable Palm Oil (ISPO) Guidelines. ISPO was issued by the Government of Indonesia through Minister of Agriculture Regulation Number 19/Permentan/OT.140/3/2011 dated March 29, 2011 [52].

The rationale behind Indonesia's implementation of the ISPO policy in 2011 is unique and interesting to talk about. Since Indonesian palm oil products are becoming more popular than other vegetable oils, the World Wild Fund (WWF), a non-governmental organization (NGO), has initiated a sustainable palm oil regime. This regime is called the Roundtable on Sustainable Palm Oil (RSPO), which was founded in 2004 in Switzerland [53]. This regime wants the development of every country in the world, including Indonesia, to comply with the sustainable development rules made by the regime. Through collaborative efforts from NGOs and western countries, the regime had the power to force Indonesia to implement RSPO regulations. However, Indonesia's membership in the RSPO stopped in 2011, and the ISPO policy came out.

The Indonesian government's implementation of the ISPO policy can be seen as a means of aligning with international environmental regulations that require industries in each country to apply the concept of sustainable development based on the existing laws and regulations in Indonesia. The ISPO is not a rejection of the RSPO regulations. Instead, it is an independent regulation from Indonesia about a system of sustainable development in the palm oil industry that synergizes with the RSPO regulations.

Another reason why Indonesia issued ISPO is as a tool that can increase the competitiveness of Indonesian palm oil in the international market. This ISPO policy is also meant to show that the palm oil industry in Indonesia is committed to not damaging the environment. ISPO was not created as a rejection of RSPO rules but as a form of adjustment to Indonesia's domestic policies [54]. This is because the ISPO policy stipulation issued by the Government of Indonesia has binding sanctions compared to the RSPO. That is what makes ISPO's policy more committed to producing environmentally friendly palm products. Even ISPO is more stringent in getting certification compared to RSPO. ISPO determines three categories of plantation classes that are used to classify plantations that are ready to receive certification and those that still need to receive training [52]. Indonesia, as the largest palm oil producer, is indeed more appropriate to implement regulations regarding its sustainable palm oil industry rather than having to be forced by other countries standards.

At present, the Indonesian government issues ISPO regulations, which continue to experience changes and developments. Based on Permentan 38 of 2020, the ISPO certification framework has 7 principles, 30 criteria, 13 sub-criteria, and 174 indicators. The implementation of ISPO principles for Indonesian oil palm smallholders based on Minister of Agriculture 38 of 2020 is mandatory. This policy was stipulated by the government so that smallholder oil palm plantations can be managed sustainably. However, ISPO implementation is still voluntary [55]. ISPO requirements apply voluntarily to: (a) plasma plantations whose land comes from government-reserved land, company land, community gardens or smallholders; (b) independent plantation businesses managed by smallholders; and (c) palm oil companies that produce renewable energy [56]. If farmers do not apply ISPO principles, it is feared that their plantation business will have an impact on environmental damage and biodiversity [57].

The ability of independent oil palm smallholders to market their plantation products to international markets is still constrained by the existence of trade regulations at the international level, which require compliance with the rules set for trade at the international level because most smallholders do not have proof of land ownership [58] and the damage caused by the palm oil industry [57]. In

addition, other obstacles faced by farmers in implementing oil palm certification are limited knowledge of cultivation, production factors, low production sustainability, and weak farmer institutions, including farmer groups, cooperatives, and combined farmer groups [59]. The Indonesian government hopes that with the ISPO, oil palm smallholders can improve their social, economic, and environmental capabilities in managing the oil palm plantations they cultivate, thereby increasing their ability to enter the international trade market and market the palm oil products they produce.

3. Research methodology

3.1. Description of the study area

This research was conducted in Bengkulu Province, which includes Bengkulu City, North Bengkulu Regency, Mukomuko Regency, South Bengkulu Regency, and Kaur Regency (Fig. 3). The research location was determined purposefully, considering that Bengkulu Province is the second-poorest province on the island of Sumatra, and according to Ref. [60], poverty in this region falls under the category of acute poverty, with the majority of the population working in the agricultural sector. Approximately 22% of the total land area of Bengkulu Province is planted with oil palm, and this palm oil plantation area contributes 2.6% to the total palm oil plantation area in Indonesia [61].

The province of Bengkulu stretches from the border of West Sumatra Province to the border of Lampung Province, covering a distance of approximately 567 km. The total area of Bengkulu Province is approximately 1,991,933 ha (19,919.33 km^2). Astronomically, Bengkulu Province is located between 2°16′ and 3°31′ south latitude and between 101°01′ and 103°41′ east longitude. From a geographical standpoint, Bengkulu Province is bordered to the north by West Sumatra Province, to the south by the Indian Ocean and Lampung Province, to the west by the Indian Ocean, and to the east by Jambi Province and South Sumatra Province. Bengkulu Province is directly adjacent to the Indian Ocean on a coastline of approximately 525 km.

Fig. 3. Research areas.

3.2. Sampling and data collection

Face-to-face interviews with farm owners, workers, value chain associates, and locals living in nearby communities were used to collect data in 2022. The sample size for each interest group was set at a minimum of 30 individuals. According to Ref. [17], the recommended minimum sample size for statistical significance is 30. Sample sizes for various stakeholders are shown in Table 1. Four types of stakeholders are involved in this study: (1) Value chain actors: growers, transporters, and mill owners; (2) oil palm plantation workers; (3) local communities, including those living within a 10 km radius of the next unit in the value chain, which are considered directly affected communities; and (4) farm owners. In practical application, it is possible to encounter individuals who possess stakeholder roles that overlap. For instance, a farm owner can also be a member of the workers. However, in this survey, such participants are excluded to avoid a biased point of view.

The farm owners included in this study were smallholders, as they are the majority of palm oil farmers in the site studied. In this study, the palm oil smallholders from the study area were chosen as respondents through a multi-stage sampling method. Bengkulu Province is recognized as one of the smallholder oil palm plantation centers in Sumatra region, chosen purposefully as the research area given its high contribution to oil palm production in Indonesia. In the second stage, out of the district's total, one municipality and four districts were purposefully selected. In the third stage, using quota sampling for each research location is necessary because the number of smallholder oil palm plantations in each research location is not known with certainty. Fig. 4 depicts a schematic representation of the sampling procedure, including the number of sampled districts and sampled households from each of the selected districts.

Data for this study was collected through a questionnaire survey of smallholder oil palm plantations in Bengkulu Province. The questionnaire was divided into three main parts: the first part collected respondents' demographic information, including their age, education level, experience, household size, and income. The second part collected the characteristics of the palm oil plantations, including land area, land status, land legality, farmer group participation, certified seeds, and replanting status. The third part of the questionnaire is about the social-life cycle of smallholder palm oil plantations based on previous research [13–16,62]. An interview session with the smallholder, workers, local community, society, and value chain actors was carried out randomly. During the interview, open-ended questions were asked to explore the respondent's perceptions, thoughts, opinions, and feelings about their working conditions before extrapolating them into weighting scores. A qualitative approach was applied in this study. According to Ref. [63], the qualitative approach is more holistic, and its design allows for insights and offers comprehensive information about an event. Methodological sheets were used to formulate the questions in line with the indicators.

3.3. Data analysis

A reference scale approach (type I) was used for impact assessment. As mentioned above, both the PSIA manual and guidelines [11] propose a five-point scale ranging from −2 to +2 to assess both positive and negative impacts. Generally, a score of 0 is used for neutral performance, compliance with local and international law, and/or basic social expectations. For this study, the reference scales with the defined PRPs by Ref. [64] were adopted for all qualitative indicators. To develop the social impact criteria in this study (Table 2), we adopted the criteria provided by Refs. [17,18,64].

4. Smallholder characteristic

The success of oil palm farmers will be determined by their ability to manage their farm so that it can become profitable and achieve family welfare. The abilities of farmers are influenced by the characteristics they possess [65]. explain that biographical characters are personal characteristics consisting of (a) Age, where there is a widespread belief that productivity declines as a person gets older. But it is not proven because many people are old but still energetic. It is recognized that a person is more productive at a young age than at an old age; (b) Gender, there are differences between men and women that affect performance, there are also those who argue that there are no consistent differences between men and women in problem-solving ability, analytical skills, competitive drive, motivation, sociability, or learning ability; (c) Marital Status, which will increase an employee's sense of responsibility for the work he is responsible for, because work is more valuable and important due to increased family responsibilities; (d) Working Period, where a longer working period indicates a person's more experience compared to other co-workers.

The characteristics of oil palm smallholders are the characteristics of farmers in believing, acting, and feeling, which include age, years of schooling, farming experience, household size, and revenue. Knowing the characteristics of farmers is one of the pieces of information needed by producers to determine the right segmentation, target market, and positioning [66].

The results of the study (Table 3) show that the average age of smallholders in Bengkulu Province is in the productive age category.

Table 1
Number of samples of each stakeholder group.

Stakeholder group	Description	Number of respondents
Workers	Employees working in oil palm plantation	100
Local community	People who live in the nearby area	50
Farm owner	Farmers who own oil palm plantations	400
Value chain actors	who are directly involved in value chain activities (wholesalers, retailers)	50

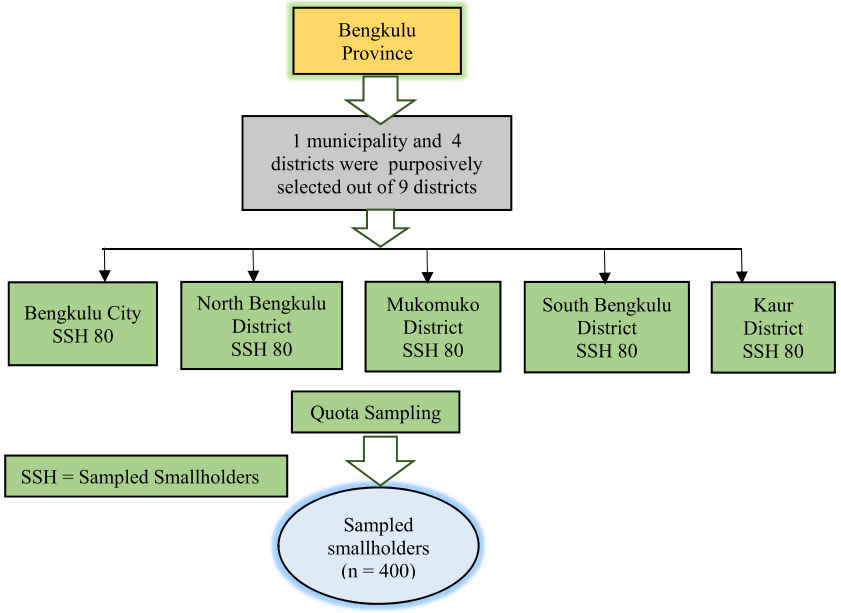

Fig. 4. Schematic presentation of the sampling procedure.

Table 2
Stakeholder categories and respective social issues and social indicators Source: adapted from [17,18,64].

Stakeholder	Social Issues	Social Indicators
Workers	Fair wage	Minimum wage (9 USD/day)
	Working conditions	Decent working hours
		Social benefit
	Health and safety	Occupational health and safety
		All workers present on the field have access to first aid
		There is protective equipment in the workplace
	Child labour	Free from the employment of child labour
	Forced labour	Free from the employment of forced labour
	Human right	Equal opportunities, free from discrimination
Community	Economic development	Local employment
	Health and safety	Safe and healthy living conditions
	Food security	Food security condition
	Community engagement	Working collaboratively with and through groups
	Employment	Percentage of employees hired
	Socio-economic repercussion	Transfer of technology and knowledge
Farm owners	Social responsibility	Participation in a group that save the environment
		Avoid the use of hazardous chemicals prohibited for use in oil palm plantations such as Furadan
	Health and safety	The first aid equipment is prepared for workers
	Satisfaction of occupation	Satisfaction in oil palm planting career
	Accessibility	Access to material resources (input)
	Tax income	Taxes imposed on the income of oil palm farmers
Value chain actors	Public commitment to sustainability	Public commitment to sustainability
	Fair competition	Fair competitive activities
	Free from corruption	Free from corruption
	Supplier relationship	Purchasing behaviour
	Convenience	Punctuality of deliveries

In the productive age category, farmers have the potential to develop farming and increase production and income. Training for farmers can be carried out for young farmers to expand and increase their knowledge about correct oil palm cultivation techniques, including the use of quality seeds, so that with the increasing age of farmers, it is expected that maximum production will be achieved. Age is an important variable because it is related to being physically strong, which is an important requirement for working as a farmer and is also related to farmer productivity. The physical strength of oil palm farmers to carry out an activity is closely related to age because when the age of a farmer has passed the productive period, his physical strength decreases, so his productivity decreases and his income also decreases [67].

Table 3
Summary statistics of palm oil plantations smallholders.

Characteristics	Min	Max	Mean	Std. Dev.
Age (years)	23.00	79.00	47.61	10.64
Years of schooling	0.00	16.00	9.48	3.09
Farming experience (Years)	1.00	56.00	18.21	9.58
Household size (person)	0.00	5.00	2.61	0.99
Palm oil revenue ($/month)	80.29	7654.02	651.46	721.74

Source: Primary data is processed, 2022.

The level of education is one aspect that can be used as an indicator of the level of household welfare. Human resources can improve their knowledge, skills, and attitudes through education. This makes them more qualified so that they can take part in every aspect of development. Most farmers have a low level of schooling, and a few of them do not go to school or have no formal education. Overall, the average education rate for farmers has reached the nine-year education target set by the Indonesian government.

Experience is an important factor in working as a farmer. From this farming experience, farmers get various pieces of information from various parties to improve the oil palm cultivation system. Thus, the experience of farmers can improve the management system of oil palm plantations so that maximum production is obtained. Palm oil smallholders in Bengkulu Province have a fairly high average experience (Table 3). This indicates that the smallholders never changed jobs as farmers. Due to their low level of education, farmers have no chance of finding jobs outside the agricultural sector. According to survey results, most farmers have 23–31 years of farming experience. Oil palm plantations have long been established, and most people rely on their existence as farmers due to the geography that supports Indonesia as an agricultural country.

The family unit is important for various interventions such as poverty alleviation, family planning, and so on. A large household size is usually also used to describe the welfare of the family, where the smaller the number of family members, the higher the level of welfare. In addition, the number of family members is also a reflection of the number of workers in the family who contribute to household business activities. The results showed that the average number of dependents in oil palm farmer families was 3 (Table 3). This number has shown that, on average, the respondent farmers have small families. This situation can illustrate that the source of labor in their oil palm plantation business is primarily from workers outside the family, especially for harvesting activities. As for plant maintenance activities, most of the work is done by farmers, assisted by their family members. The minimum number of family members will affect the fulfillment of food and non-food consumption needs. With a small number of family members, spending on non-food consumption is relatively more fulfilling. Farmers can allocate greater expenditures for their business activities by intensifying, extending, or even diversifying their businesses.

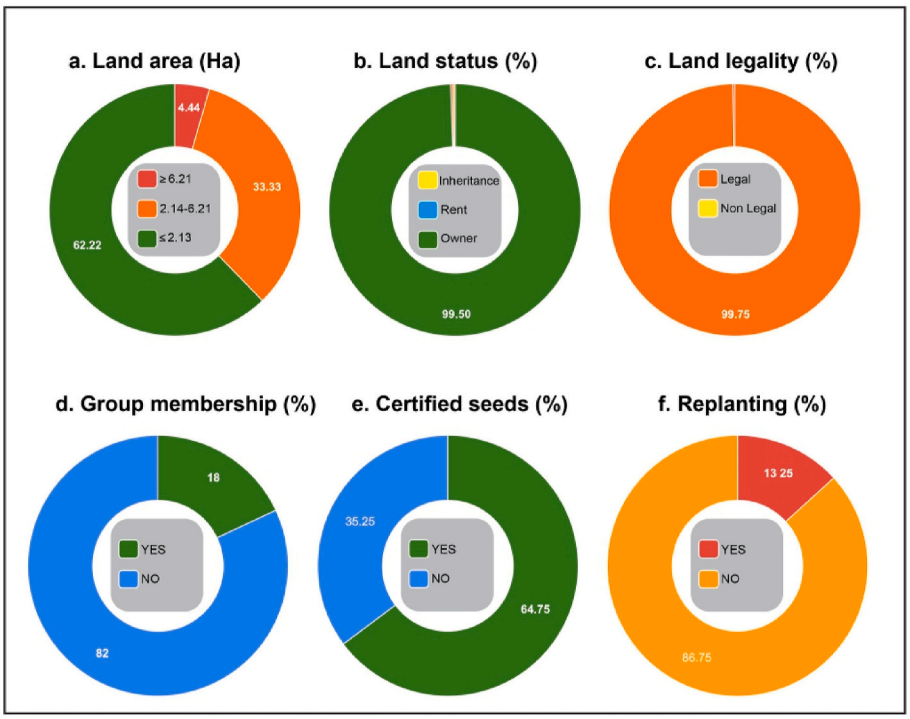

Fig. 5. Palm oil plantation characteristics.

5. Oil palm plantations characteristics

The oil palm plantation's characteristics include land area, land status, land legality, group membership, certified seeds, and replanting (Fig. 5). Land area is one of the most important factors agricultural production because farming activities, including the type of commodity and farming patterns, are influenced by the land area managed by farmers. The land area affects the income derived by farmers from their farming activities [68]. The research findings (Fig. 5a) indicate that the majority of farmers have land areas of less than 3 ha. According to Presidential Instruction Number 1 of 1986, dated March 3, 1986, the recommended land area for each farmer is a minimum of 2 ha. This corresponds to the guidelines for developing smallholder plantation patterns associated with transmigration programs.

Farmers with small land areas, specifically $\leq$3 ha, must have additional jobs (side jobs) to meet their family's needs [69]. The fluctuating prices of production are a major issue faced by farmers. The average price of palm fruit, which varies each year, also results in varying average incomes for farmers.

Land legality is a crucial variable for oil palm farmers as it pertains to land ownership and farming rights. For oil palm farmers, land legality takes the form of land certificates issued by authorized officials, such as those issued by the National Land Agency. Land legality and ownership status are essential requirements for farmers to obtain sustainable palm oil certification, or ISPO. The majority of farmers cultivate oil palm on their own land (Fig. 5b) and possess valid land ownership documents (Fig. 5c).

A group is a collection of individuals who interact with each other to achieve common goals, and there is interdependence among individuals within the group. Being a member of a group provides benefits not only to individuals but also to the broader community. One of the benefits is facilitating oil palm farmers in the replanting process. The research findings (Fig. 5d) show that only 64.75% of independent oil palm farmers actively participate as members of groups, such as cooperatives, farmer groups, women farmer groups, or other groups. The groups that farmers join are considered to assist them in their oil palm farming activities, including providing capital loans, savings, information, marketing support, and even the latest innovations in oil palm plantation management. Farmer groups serve as a communication channel between farmers and other stakeholders in managing their farming activities. Furthermore, the presence of farmer groups is a response to government programs and other relevant stakeholders.

One factor that affects the growth and development of oil palm plants is innate [70]. Innate factors are related to the plant's genetics and are absolute, starting with the formation of the embryo within the seed. For farmers, selecting certified oil palm seedlings is an action that can be taken to ensure the management of innate factors. Fig. 5e shows the majority of oil palm farmers have used certified seedlings, but there are still quite a few who use uncertified ones. Farmers propagate their own seedlings using random seedlings from planted oil palm trees, resulting in a wide range of genetic diversity and a generally low genetic quality of oil palm plants. Even though plants with low genetic quality receive optimal care, they cannot achieve maximum production because they are less responsive to fertilizers.

Smallholder oil palm plantations are currently entering the less productive stage and tend to be less productive, requiring efforts to

Table 4
Aggregated results for the stakeholder group.

Stakeholder	Indicators	Performance point
Workers	Minimum wage (9 USD/day)	−1.573
	Decent working hours	0.864
	Social benefit	1.370
	Occupational health and safety	−1.969
	All workers present on the field have access to first aid	−2.000
	There is protective equipment in the workplace	−2.000
	Free from the employment of child labour	1.036
	Free from the employment of forced labour	−1.047
	Equal opportunities, free from discrimination	0.473
Community	Local employment	1.763
	Safe and healthy living condition	0.587
	Food security condition	−1.020
	Working collaboratively with and through groups	1.750
	Employment	0.684
	Transfer of technology and knowledge	1.971
Farm owners	Participation in a group that save the environment	−1.760
	Avoid the use of hazardous chemicals prohibited for use in oil palm plantations such as Furadan	−1.988
	The first aid equipment is prepared for workers	−2.000
	Satisfaction in oil pam planting career	0.592
	Access to material resources (input)	1.230
	Taxes imposed on the income of oil palm farmers	−1.880
Value chain actors	Public commitment for sustainability	−1.020
	Fair competitive activities	0.250
	Free from corruption	1.200
	Purchasing behaviour	1.860
	Punctuality of deliveries	1.250

Source: Primary data, 2022.

improve production for the well-being of farmers. One of the necessary efforts is the oil palm replanting program. Based on Fig. 5f, it can be seen that nationally, only 13.25% of respondent farmers have implemented oil palm replanting on their land, while 86.75% have not. This needs attention because the replanting program is a national program, and the government should assess the problems and solutions at the farmer level regarding their reluctance to engage in replanting. Despite the financial incentives provided for replanting, it still poses challenges for farmers. Some identified issues include the fear of losing their main livelihood when their plants undergo replanting, as this program is a new innovation for farmers. Additionally, the limited capital and technical capabilities of farmers in conducting replanting are major reasons why they have not undertaken replanting yet.

6. Social-life cycle assessment palm oil plantations

6.1. Results

After evaluating all collected data against the adopted reference measures and PRPs, the results are presented as a concise summary table for each indicator group and individual radar charts for each stakeholder. This research is interesting and different from previous research, where all social indicators used were qualitative. The results of the study (Table 4) show that the majority of workers (palm workers) do not reach the minimum wage. Furthermore, oil palm plantation workers throughout Indonesia generally face the same problem, namely conditions where workers are in precarious employment relationships without job security guarantees (freelancers, wholesale workers, contract workers, and outsourced workers), resulting in poor employment. The majority of workers are employed as casual workers or casual daily laborers who earn less than the minimum wage. In the context of welfare, oil palm workers dominate the face of poverty for oil palm plantation workers. Workers (palm workers) also do not have access to health insurance The results of the study in Table 4 show that all workers agree that there is no access for palm oil workers to get first aid kits. The equipment used by workers is also minimal in terms of safety standards. However, healthcare facilities are crucial in providing first aid to workers who experience work-related accidents when spraying fertilizers and chemicals. Ideally, palm oil plantations should provide personal protective equipment for palm oil workers, including helmets, goggles, masks, and boots.

The results showed that there were still children working in smallholder oil palm plantations (Table 4). In Indonesia, this group of children is in the age range of 5–17 years [2]. The phenomenon of child labor in Indonesia is closely related to the level of community welfare, namely the problem of poverty.

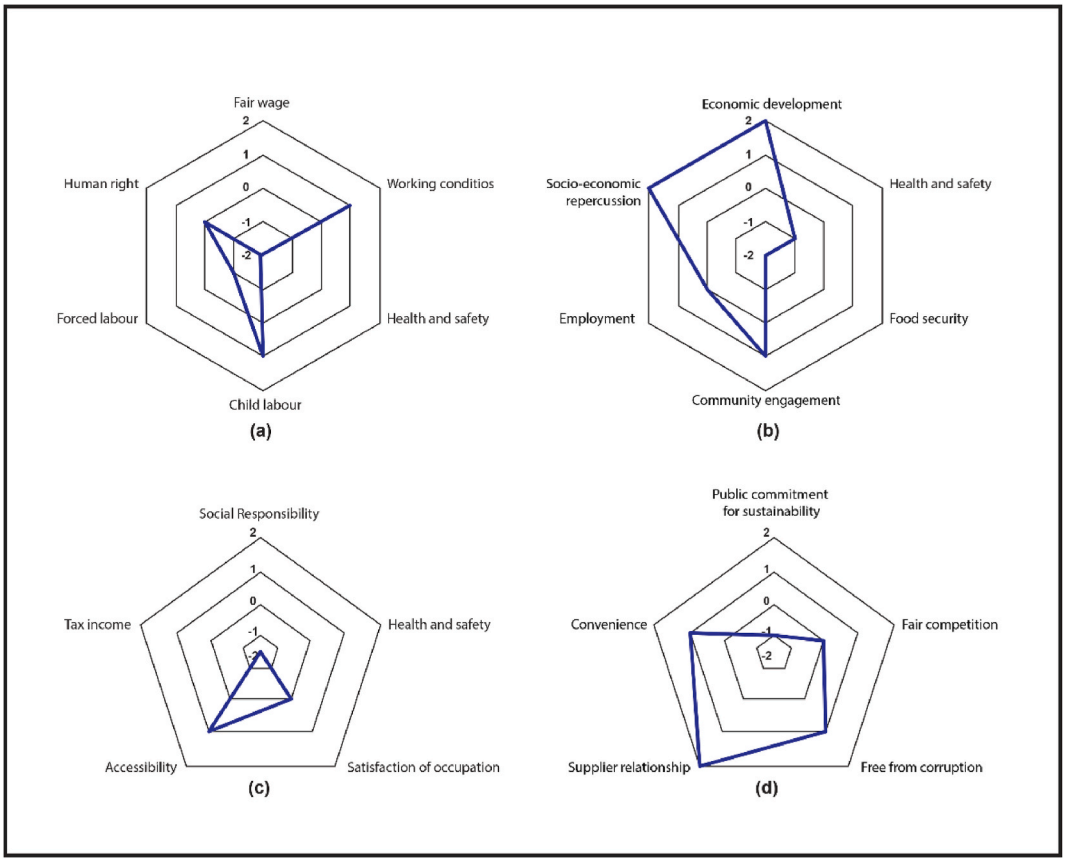

Fig. 6. Detailed results for (a) workers, (b) community. (c) Farm owner, (d) value chain actors.

The majority of farmers have an average land area of less than 2.13 ha (Fig. 5) and are small-scale farmers, so plantation management does not require a lot of labor (Table 4). Workers who are employed in the management of oil palm plantations are also usually from the community around the village. The results also show that fluctuations in the price of fresh fruit bunches (FFB) threaten the poverty levels of farmers and consequently affect the achievement of household food security for smallholder palm oil farmers (Table 4), especially those with land areas less than 2 ha.

The majority of farmers who own oil palm plantations make oil palm plantations their main business, which can meet their primary and secondary needs. So, farmers must cooperate with other institutions (Table 4) involved in oil palm plantations, especially in terms of marketing fresh fruit bunches (FFB). With the collaboration of oil palm farmers with other institutions such as farmer groups, village collectors, input providers, and other institutions involved in oil palm plantations, it is possible for farmers and surrounding communities to exchange information about technology and share knowledge (Table 4).

The results of the study (Table 4) also show that in the farm owner group, there are no farmers involved in farmer groups that have a focus on the environment. Farmers are still unaware of the importance of environmental protection. Oil palm farmers in Bengkulu province also have less satisfaction with their work as oil palm farmers (Table 4). In the group of value chain actors, the most important problem to overcome is the commitment of various parties to sustainability (Table 4).

Fig. 6 shows that the health and safety indicators for workers (Fig. 6a), the community (Fig. 6b), and farm owners (Fig. 6c) have negative values. In addition, the results of the study (Fig. 6) also show that smallholder oil palm plantations have a negative social impact on forced labor (Fig. 6a), food security (Fig. 6b), social responsibility (Fig. 6c), tax income (Fig. 6c), and public commitment to sustainability (Fig. 6d). People's oil palm plantations are also not free from social problems.

6.2. *Discussion*

The low minimum wage in Bengkulu province is IDR 2,418,280 per month, or equivalent to IDR 80,609 per day or 5.17 USD per day. This is different from the palm oil workers on private plantations, who receive wages above the regional minimum wage in Bengkulu Province. For example, in Mukomuko District, palm oil workers in private plantations earn wages of IDR 90,527 per day or 5.80 USD per day, which is above the regional minimum wage in Bengkulu Province. In general, oil palm plantation workers' earnings are determined solely by the number of working days, based on their effective working days. The work usually carried out by oil palm workers includes grass trimming, maintenance, fertilizing, harvesting, and bald palm fruit, which is not done every day. Workers will be contacted by oil palm plantation owners if there is work to be done. There are even smallholder palm oil plantation owners who also work on their own farms to reduce labor costs. Within palm oil plantations, there is an imbalanced relationship between men and women, where female workers are placed in low-wage and high-risk positions in terms of health and safety. The reason for providing different wages is that the work is performed by female workers. This is consistent with the research by Ref. [71], which states that employment opportunities for women in palm oil plantations are generally in areas such as seedling planting, pest and disease control, picking up loose fruits, and maintaining plates. The contributions of female workers in palm oil plantations will have an impact on the household economies of palm oil plantation workers.

A living wage, which is the right of every worker and guaranteed by the constitution (Fig. 7), is often interpreted differently by management interests in almost all oil palm plantation companies. The main issues and problems that continue to plague palm oil workers are employment status, industrial relations, occupational health and safety facilities, health, low wages, and high workloads and targets. Thus, the problems faced by oil palm plantation workers are not single but multidimensional and interact with each other. The multidimensional problems faced by oil palm plantation workers with various class identities (gender, age, and ethnicity) have resulted in multi-layered and different impacts from each identity.

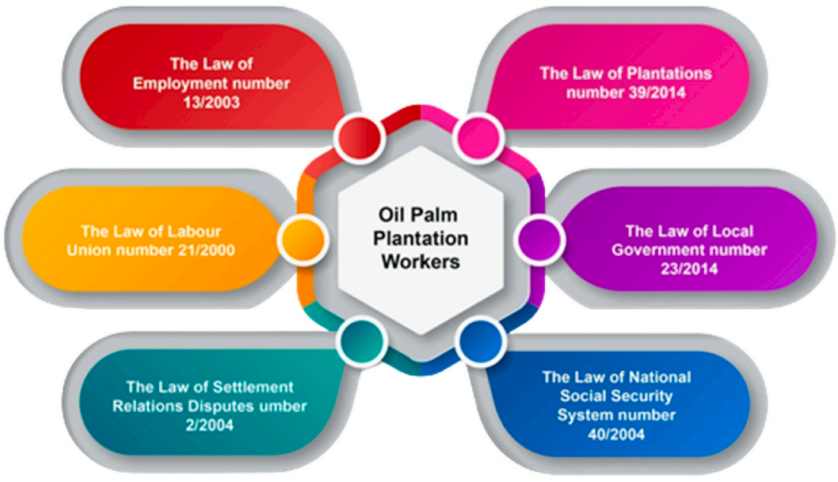

Fig. 7. Palm oil plantation workers in a circle policy.

The majority of child workers who work in oil palm plantations are the children of plantation owners and work to help their parents. The work that is usually done is cleaning and maintaining oil palm plantations, which are of course adapted to the age and physical condition of the children. Related to the existence of child labor in the family's oil palm plantations due to the preservation of traditional values by the local community. Parents may believe that employing children in the family palm oil business is good for the regeneration process. Parents assess their child's willingness to work as a form of respect.

Oil palm labor needs are influenced by plantation area, type of work, topography and climate, technology, and the composition or age of the plant [72]. The form of cooperation implemented by both parties uses a wage system in which oil palm plantation owners pay harvesters. If the farm owner pays the harvester's wages as agreed by the parties and applies to only one harvest. The farm owner at the time of harvesting, agrees on the cost of wages to be paid to the harvester or cultivator in accordance with the agreement. Garden owners usually provide tools such as "dodos", "egrek", "carts", "gancu" and others needed by workers [73].

At the national level, palm oil production contributes to poverty alleviation, as indicated by lower poverty rates in areas surrounding palm oil plantations [74,75] and faster overall poverty reduction [76]. Significant economic improvements have also been reported for other actors involved in the supply chain, such as traders and intermediaries [77–79]. However, FFB price fluctuations pose a threat to oil palm farmers for household welfare and family food security. Findings from the research sites indicate that the contribution of palm oil income to household food expenditure reached 95.67%. This means that almost one hundred percent of the palm oil income can cover household food expenditures. However, palm oil income is still insufficient to meet all household food and non-food needs. This is due to the average land area owned by farmers, which is only around 2 ha, with an average production of 49.68 tons per year, which is relatively small compared to the production of Bengkulu Province, which is 234,830 tons per year [80].

Most of the farmers in the study area participate actively in farmer groups. The government's policy on fertilizer subsidies through the proposal for a definitive plan for farmer group needs (Group needs definitive plan) has also increased the demand and desire of farmers to be involved in the membership of oil palm farmer groups. In addition, farmers have relationships with FFB collectors at the village level who act as marketing agencies for FFB to CPO (crude palm oil) factories around the sub-district. Harvesting and transportation to the factory need to be carried out properly in order to obtain fruit with a high oil yield and good oil quality. FFB from the retailers must be immediately transported to the factory for processing. Fruits that are not processed immediately will be damaged [81].

Plasma palm oil plantation schemes can benefit small-scale farmers, particularly through the transfer of superior technology and production inputs [e.g., [82]]. The establishment of large-scale agro-industries through nucleus plantations can enhance agricultural productivity, creating employment opportunities. And contribute to rural development in general, for example, through the development of inputs and other market factors, as well as infrastructure improvements [83,84]. At the village level, village economic enterprises are being transformed into village-owned enterprises (BUMDes), one of which is capable of organizing independent oil palm smallholders to develop palm oil productive economic businesses. Through the development of BUMDes, farmers have other platforms besides farmer groups to share problems and find solutions to overcome problems that arise in oil palm plantations. Consider the ISPO, RSPO, and replanting activities that are currently being carried out in Bengkulu Province.

The development of oil palm plantations in the Bengkulu region has brought about a significant change in the situation of rural communities, especially migrant communities (transmigration), as the oil palm plantation development program was originally associated with the transmigration program. Moreover, the development of palm oil plantations will also stimulate the growth of the palm oil-based processing industry. This condition causes the high mobility of the population in the Bengkulu area, especially in the area of oil palm plantation development. Oil palm is one of the most important and strategic commodities in the Bengkulu area because of its large role in encouraging the people's economy, especially for plantation farmers. This is quite reasonable because the Bengkulu area is indeed suitable and has the potential for plantation agricultural development. With a large number of workers and relatively large investments in downstream industries, oil palm plantation development activities are aimed at actively stimulating, growing, and creating employment and business opportunities. Backward links are created through the development of economic activities and downstream industries that produce the goods and services needed in the course of oil palm plantations. Within this activity, construction services, agricultural services, transport services, trade in food and clothing, trade in working tools and materials, as well as materials required during the process, are provided. On the other hand, post-harvest economic activity and production processes have a positive link. The process of forward collaboration that is expected to emerge will take place in the service sector, including: transportation, hotels, cooperatives, banking, trade, and small-scale industries in rural areas producing agricultural production equipment [85].

The majority of farmers are not part of a farm group that has a focus on environmental sustainability. For example, in weed control, most farmers carry out chemical weed control with herbicides, which are considered the most practical, effective, and economical. The advantages of using herbicides include: (1) reducing the amount of labor for weeding weeds that grow with plants or in areas that are difficult to weed mechanically; (2) reducing root damage caused by mechanical weeding; and (3) reducing the level of erosion in plantation areas [86,87]. In addition, in practice, not all farmers use complete personal protective equipment for occupational safety and health during herbicide application. Farmers find it difficult to fully use personal protective equipment, so they think their work productivity can be reduced. This shows that the level of awareness of farmers towards the use of personal protective equipment when applying herbicides to oil palm plantations is low. For this reason, assistance is still very much needed, both in the form of counseling and training on occupational health and safety in the application of herbicides to weed control in oil palm plantations [88].

Independent farmers do not receive direct support from the government and often have low production yields. This leads to low farmer satisfaction with his work as an oil palm farmer. They frequently lack agronomic knowledge, such as proper fertilizer dosage and adequate harvest cycles, as well as financial resources and access to high-quality seeds [44–48]. Furthermore, the price of fresh fruit bunches continues to fluctuate, and unpredictable government policies are the reasons for farmers' disappointment. Palm oil

production tends to increase, but the price of palm oil and its derivative products tends to fluctuate. The price of palm oil has a significant influence on the welfare level of farmers in the Bengkulu region [89]. According to a quantitative study conducted on small-scale oil palm farmers in Peninsular Malaysia [90], the majority of respondents are willing to participate in palm oil sustainability if they can expect financial benefits, such as premium prices and affordable costs.

The government has enacted Plantation Law No. 39/2014. This law contains provisions on sustainable plantation development. The law essentially obliges companies to comply with standards for the sustainable development of oil palm plantations by complying with all applicable laws and regulations in Indonesia. Plantation enterprises pay attention to economic factors and the social welfare of the community and surrounding areas and show concrete signs of improving the welfare of the community by strengthening the economy of the community. Owned by the community. A sustainable oil palm plantation is an application of the concept of sustainable agriculture, namely an agricultural system that is designed to balance the economy, society, and the environment. These demands were met through the implementation of RSPO and ISPO in oil palm plantations. However, so far, there are still many unsustainable plantations, so the negative impact of oil palm plantations is still being felt in various areas, especially in the Bengkulu area. The haze disaster as a result of land fires in oil palm plantation areas, the use of child labor, land conflicts, and the low welfare of the workforce are implications of unsustainable plantations [8].

The majority of workers are employed as casual workers who earn less than the minimum wage. They are also burdened with high work targets, so they often have to work overtime, but overtime wages are not paid. These casual workers also do not have access to social health insurance or adequate equipment to ensure their occupational health and safety. The conditions faced by women workers in oil palm plantations are even more complicated; single women find it difficult to be appointed as workers, even though they have worked for the plantation for a long time. Meanwhile, work activities that carry gender-specific health risks (reproductive health for women workers) are almost never handled properly. Poor road access from the main road to oil palm plantations and housing makes oil palm plantation workers far from accessing local government social assistance and proper health facilities—even though the company has provided clinics in residential areas, the numbers of buildings, health workers, and drugs are minimal. Moreover, poor road access makes oil palm plantation workers very vulnerable in special conditions such as natural disasters, disease outbreaks, and serious illnesses, even in the case of mothers giving birth.

Social problems arise from the reduced state attention to the issue of indigenous peoples, which makes the oil palm plantation business a trigger for social conflicts and land disputes (ownership) among indigenous peoples [91]. Not only is overlapping between plantation lands and customary lands increasing land conflicts, but it also triggers local food vulnerability due to shifting traditional farming patterns [92]. [93] argues that oil palm plantations have great potential to affect socio-economic relations and customary lands.

Thus, the problems faced by smallholder oil palm plantations are not single but multidimensional and interact with each other. To overcome the various problems of oil palm plantations in Indonesia, the certification approach is an option. Efforts to develop certification for palm oil began with the establishment of an organization called the RSPO in 2004. This RSPO organization then issued a voluntary market-based policy instrument to respond to consumer demands for sustainable palm oil products. As such, the RSPO is a not-for-profit association that brings together global stakeholders in the palm oil industry—palm oil producers, palm oil processors or traders, consumer goods manufacturers, retailers, banks, investors, and environmental and social NGOs. The RSPO certification scheme minimizes the involvement of the state government in the stages of standard preparation, implementation, and evaluation, so RSPO is often referred to as a form of private governance. Balancing state involvement in the management of oil palm certification is seen as being able to overcome the inability of developing countries to design, implement, and enforce regulations related to natural resource management [94]. With its approach of reducing state involvement, the RSPO is considered capable of realizing improvements in oil palm governance in developing countries whose capacity to enforce regulations is often questioned [94].

7. Conclusions

Improving the compliance of small-scale farmers with sustainability standards and good agricultural practices is a prominent aspect of the global sustainability agenda. Through Social-Life Cyle Assessment analysis, this research contributes to that need by developing typologies of small-scale farmers in Indonesia, particularly in Bengkulu Province. This S-LCA case study provides an assessment of social impacts related to palm oil plantation smallholders. For the analysis, four stakeholder groups that are outlined in the S-LCA Guidelines [11] were considered: workers, communities, farm owners, and value chain actors. Partly, the results of the case study are not as expected; for example, there are no farmers involved in farmer groups that have a focus on the environment. Farmers are still unaware of the importance of environmental preservation. For example, in weed control, most farmers carry out chemical weed control with herbicides, which are considered the most practical, effective, and economical. Oil palm farmers in Bengkulu province also have less satisfaction with their work as oil palm farmers. The price of fresh fruit bunches continues to fluctuate, and unpredictable government policies are the reasons for farmers. Palm oil production tends to increase, but the price of palm oil and its derivative products tends to fluctuate.

Surprisingly, the results of the study also show that the majority of workers (palm workers) do not reach the minimum wage. Oil palm plantation workers are in conditions of precarious employment (without job security guarantees (freelancing daily labor force, piece workers, contract workers, and outsourcing), resulting in poor working conditions. The majority of workers are employed as casual workers or daily laborers. Freelancers who earn less than the minimum wage. In the context of welfare, palm oil workers dominate the face of poverty among oil palm plantation workers. Palm workers also lack access to social health insurance and adequate workplace equipment to ensure their health and safety.

The government needs to formulate policies related to various issues faced by small-scale farmers. The selling price of palm oil is

relatively unstable for a country that is the largest producer of palm oil, mainly due to the low productivity of small-scale palm oil plantations. The lack of land ownership by the majority of palm oil farmers also limits their access to the ISPO and RSPO certification processes, business financing, government and private assistance programs, and their position in the palm oil industry value chain. Official land ownership is crucial for palm oil farmers, who bear the greatest burden of the current challenges of spatial planning in the palm oil sector. Therefore, the active role of the government in certifying palm oil plantation land plays an important role in expanding farmers' access to financial aspects. Furthermore, we recommend early strengthening of farmer groups in the growing sectors to enhance bargaining power and future market access. This is crucial considering the dissatisfaction of small-scale palm oil farmers with their work. Farmer groups can provide suitable platforms for extension services and technology transfer. In fact, farmer groups have become integral elements of the ongoing replanting program initiated by the Indonesian government.

A major limitation of this study is that the qualitative index results are based on a limited number of interviews, and the absolute reliability of the results cannot be guaranteed. To improve the results and further validate the selected indicator set on the corresponding reference scales, this study should be extended to other areas with different oil palm plantation characteristics in other geographical regions. In general, evaluating social impacts using the S-LCA provides a holistic assessment of the use and full review phases, taking into account the four categories of stakeholders and their respective social impacts. Validation and verification of results in S-LCA are considered important areas for developing further research. This research contributes to evaluating social impacts on strategic sectors in Indonesia by using the S-LCA which is still very limited in use as an analytical tool, especially in the Indonesian region.

Consent for publication

Consents for publication from all the co-authors are received.

Author contribution statement

Gita Mulyasari: Conceived and designed the experiments; Analyzed and interpreted the data; Contributed analysis tools or data; Wrote the paper.

Ira Nurhayati Djarot: Conceived and designed the experiments; Contributedanalysis tools or data.

Nugroho Adi Sasongko: Conceived and designed the experiments.

Agusta Samodra Putra: Conceived and designed the experiments; Contributed analysis tools or data; Wrote the paper.

Data availability statement

Data will be made available on request.

Declaration of competing interest

This manuscript was not submitted or published to any other journal. The authors declare that the manuscript is an original paper and contain no plagiarised text. All authors declare that they are not currently affiliated or sponsored by any organization with a direct economic interest in subject of the article. My co-authors have all contributed to this manuscript and approve of this submission.

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