



Associations Among Oil Palm Farmers' Economic, Sociocultural, and Environmental Perceptions in Central Kalimantan, Indonesia

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ABSTRACT

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The expansion of oil palm cultivation has been associated with substantial economic, sociocultural, and environmental changes in producing regions; however, the interrelationships among these aspects from the perspective of oil palm farmers remain insufficiently understood. This study examined the associations among farmers' perceptions of the economic, sociocultural, and environmental aspects of oil palm cultivation in Central Kalimantan, Indonesia, and developed a preliminary instrument for measuring these perceptions. Farmer characteristics were summarized using descriptive statistics, while perceptions of the three aspects were assessed using Likert-scale items. The internal consistency of the items representing each aspect was evaluated using Cronbach's alpha before the associations among aspects were examined. Item scores within each aspect were aggregated to generate composite scores, and Spearman's rank correlation coefficients were subsequently calculated to quantify the strength and direction of the associations among the three aspects. Cronbach's alpha coefficients exceeded 0.80 for all aspects, indicating good internal consistency of the corresponding item sets. Spearman's correlation coefficients indicated positive associations between the sociocultural and environmental aspects (0.286), the economic and environmental aspects (0.382), and the economic and sociocultural aspects (0.726). According to commonly used classification criteria for correlation strength, the first two associations were weak, whereas the association between the economic and sociocultural aspects was strong. The results provide preliminary empirical evidence of the interrelationships among farmers' perceived economic, sociocultural, and environmental aspects of oil palm cultivation and establish an initial measurement instrument that can be subjected to further psychometric validation. Further validation across larger and more diverse farmer populations is required before the instrument can be broadly applied to studies of oil palm farming systems in Indonesia and other oil palm-producing contexts.

1. INTRODUCTION

Palm oil is one of the most important agricultural products and plays a significant role in various aspects of human activities. Its importance is reflected in the extensive research conducted, ranging from genetic engineering and plant breeding to the optimization of fertilizer use, aiming to increase the oil palm yield [1-5]. Research on oil palm production systems has also been conducted, particularly the development of cultivation techniques and management models adapted to local conditions for high yields and

sustainability [6-13]. Oil palm wastes are hazardous for the environment when poorly managed. However, when appropriately managed, the wastes can be converted into valuable resources, including fuel for diesel generators in rural areas [14-20].

The economic aspect is also an important dimension of oil palm production, as farmers must consider several factors when making decisions concerning production and resource allocation. Tabe-Ojong et al. [21] found that profitability of oil palm production is influenced by several factors, including market orientation, access to market information, land tenure

stability, access to improved farm inputs, transaction costs, and labor availability. These factors are important in determining production outcomes across different scales of oil palm farming. Krishna and Kubitzka [22] also discovered that the expansion of oil palm cultivation had a strong and positive effect on the supply of private goods and the majority of community goods, including facilities provided by communities or governments that benefit local households. Tapia et al. [23] found that about 4.5 million hectares of land in Malaysia and Indonesia could produce 1.3 million tons of sustainable palm oil each year. However, the land is scattered across the islands, which poses development challenges, highlighting the importance of affordable and fair certification mechanisms for enabling smallholders to participate in sustainable production. In Papua New Guinea, Hambloch [24] concluded that understanding land formalization requires analyzing contextual factors like the local economy. Instead of focusing on whether land formalization is effective, its outcomes should be evaluated according to who benefits and under what conditions these benefits occur.

Another important dimension of oil palm production is the sociocultural aspect, because it describes the social dynamics that have developed alongside the expansion of the oil palm industry. Chrisendo et al. [25] concluded that oil palm production improved living conditions (such as ownership of family assets and electricity usage) and human capital (improved nutrition and dietary quality and increased expenditures for education) in smallholder agricultural households. Conflicts concerning oil palm development have often involved local communities protesting without using formal channels or even having legal rights. About 68% of conflicts remained unresolved due to limitations of existing laws and collusion between stakeholders and companies [26]. Those conflicts are often associated with illegal access to land. Astuti et al. [27] found that accurate spatial data are essential for identifying such issues, but the way these data are applied and prioritized in governance—especially through land-use classification and zoning—determines who ultimately benefits when illegal land use is identified. Gender constitutes another important sociocultural dimension of oil palm production. Oil palm cultivation is linked to reduced female involvement in crop-related decision-making and income control, likely because women in oil palm households participate less in farm production and marketing than those in households growing traditional crops [28]. Rowland et al. [29] also found that women's well-being and gender equity were impacted by changes in their time allocation at oil palm sites, as this increased their time pressure and reliance on coping mechanisms.

Sociocultural and economic aspects are also often closely related to the environmental aspect in the oil palm cultivation process, and two or more of these aspects often intersect with each other. Tan et al. [30] found that the key to the sustainable environment–food–energy–water nexus in palm oil production is managing polluting mill effluent, which can be resolved by an integrated complex that aims to minimize waste generation in crucial processes. Palm oil mills generate large amounts of effluent that releases methane. However, microalgae can be used to treat this waste, producing bio-diesel while significantly reducing greenhouse gas emissions associated with methane release, diesel combustion, and fossil fuel-based electricity generation [31]. Gourich et al. [32] found renewable energy access in remote areas by producing bio-diesel from non-edible sludge palm oil at rural palm oil

mills. Compared with commercial B30 diesel, this approach was reported to provide greater climate benefits and could supply electricity to around 940 nearby households for a mill processing 40 tons of fresh fruit bunches per day. Xin et al. [33] calculated that the demand of oil palm products would reach about 313–679 million tons in 2050 and would require 18.58–45.59 million hectares of new plantations, potentially converting 8%–22% of secondary forests and 21%–54% of peat-lands. However, redirecting future expansion to low-value degraded land could reduce carbon dioxide emissions by 87–142 million tons per year despite higher transport and infrastructure costs. Such a transition could be supported through stronger policy support, stricter peat-land protection, improved infrastructure, and economic stimulus. The application of magnesium-rich synthetic gypsum, a by-product of chemical manufacturing, had effects similar to Chinese kieserite to boost soil fertility. Therefore, it can become an alternative magnesium source for oil palm grown on Ultisols. Environmental monitoring also showed a safe impact on soil properties, metal uptake, and oil quality of oil palm trees [34]. In Northeast India, oil palm-based agroforestry systems established on jhum land were reported to improve crop yields while increasing ecosystem carbon stocks in degraded landscapes [35]. Plantation undergrowth can provide animal feed with crude protein levels exceeding cattle requirements and approximately 1.6 times the energy needed for maintenance. Nevertheless, energy shortfalls may still occur and can be addressed with oil palm kernel meat, a byproduct of palm kernel oil production. The higher-than-recommended carrying capacity suggests that increasing stocking density through integrated oil palm–cattle systems can boost beef production, improve resource efficiency, and reduce pressure for further deforestation in Malaysia [36].

The relationships between oil palm cultivation and individual economic, sociocultural, or environmental aspects have been examined extensively. Previous studies indicate that these aspects may be interrelated; however, little research has studied their interrelationships from the perspective of oil palm farmers. Hence, this study aimed to reveal the associations among oil palm farmers' perceptions of economic, sociocultural, and environmental aspects in Central Kalimantan Province, Indonesia. This research is expected to support policymakers with additional information when formulating policies for the oil palm sector, improve understanding of the interrelationships among the sociocultural, economic and environmental aspects within oil palm farming communities, and provide a basis for further research in the oil palm production sector.

2. LITERATURE REVIEW

2.1 Economic aspect

The development of the palm oil sector has not only contributed to increased household incomes but has also structurally transformed the rural economic system. Employment on palm oil plantations has become a key component of household income generation, often even more significant than traditional agricultural commodities such as food crops [22, 37]. This situation indicates that palm oil expansion creates relatively more promising economic opportunities for smallholder farmers and local labor. Furthermore, the presence of palm oil plantations has driven a

shift in community livelihoods from subsistence to wage-based employment, such as plantation labor and derivative economic activities related to the palm oil value chain [38–40]. This transformation has resulted in increased purchasing power, reflected in increased household consumption, asset ownership, and access to household necessities [22, 25].

However, this increase in welfare is not entirely without consequences. The community's economic dependence on one primary commodity, palm oil, is growing stronger as income diversification shrinks. This dependence increases household vulnerability to global price fluctuations and palm oil market dynamics [38]. Therefore, while palm oil plantation expansion has been shown to reduce unemployment and improve economic well-being in the short term, in the long term, this phenomenon has the potential to create structural risks if not balanced with local economic diversification strategies.

2.2 Sociocultural aspect

Various studies have shown that land clearing and the development of oil palm plantations not only impact the economy but also trigger social and cultural transformations in surrounding communities. Increased economic activity resulting from oil palm expansion has been shown to drive higher living standards through increased income and market integration, which in turn leads to improvements in housing conditions, sanitation, healthcare, and overall household well-being [40, 41]. Chrisendo et al. [41] even emphasized that this economic improvement has transformed rural lifestyles, including increased access to technology, modern services, and digital communications. Further impacts are evident in the education sector, where the establishment of oil palm plantations is associated with increased school enrollment and strengthened human resource capacity, both through increased household income and the development of educational facilities around the plantation areas [42].

On the other hand, the shift in land use from subsistence agriculture to palm oil commodities also impacts consumption patterns and household economic well-being [22], while simultaneously contributing to a shift in local livelihoods from shifting cultivation toward oil palm farming and plantation employment [43]. This economic transformation indirectly creates a new social stratification and shifts the traditional agrarian social structure to a more market-oriented society. However, several studies also point to complex sociocultural consequences, such as the neglect of customary rights, the erosion of local cultural institutions, and the loss of living spaces with high cultural value [44]. Furthermore, the shift in employment relationships from mutual cooperation to company-based relationships also influences the social interaction patterns of rural communities [45]. Thus, the clearing of oil palm plantations can be understood as a transformational factor driving changes in the sociocultural status of communities—both through increased welfare and modernization and through disruption of traditional social structures and cultural values.

2.3 Environmental aspect

Environmental quality is fundamentally formed from the interaction between landscape structure, ecosystem function, and ecological stability, all of which support each other. Well-managed landscapes not only maintain environmental balance

but also play a role in reducing the risk of disasters such as floods and landslides by increasing infiltration capacity and land stability [46]. Under these conditions, ecosystem services can function optimally—maintaining water availability, reducing vulnerability to drought, and supporting ecological productivity, which is the basis for biodiversity [47]. The presence of healthy flora and diverse fauna reflects high environmental quality and indicates overall ecosystem stability [48].

The role of green infrastructure, such as green open spaces and urban forests, further strengthens environmental quality by improving air quality and other ecological functions [49]. However, this balance is vulnerable to disruption by large-scale land-use changes, including the establishment of oil palm plantations, which trigger significant landscape transformation. Land conversion to oil palm plantations can directly degrade soil quality through reduced carbon stocks and changes in soil structure [50] and indirectly through increased surface runoff, which leads to loss of soil nutrients [51]. At the same time, oil palm plantation expansion also brings changes to rural landscapes through the construction of road networks, increased accessibility to remote areas, and inter-regional integration, indicating that the impacts of oil palm land clearing are not only ecological but also affect the socio-economic dynamics of the surrounding area [39].

3. METHOD

3.1 Study area and period

The research was conducted from January to March 2023 in Central Kalimantan Province, Indonesia. Central Kalimantan was selected as the study area because it was one of three biggest oil palm-producing provinces in Indonesia in 2021 in terms of planted area and production, with approximately 1.8 million ha of planted area and 8.6 million tons of production [52]. Six villages in Central Kalimantan were selected for this study: Pematang Village, Tumbang Tilap Village, Palangan Village, Bagendang Tengah Village, Pematang Limau Village, and Tanjung Rangsang Village. The locations of the sampled villages are shown in Figure 1.

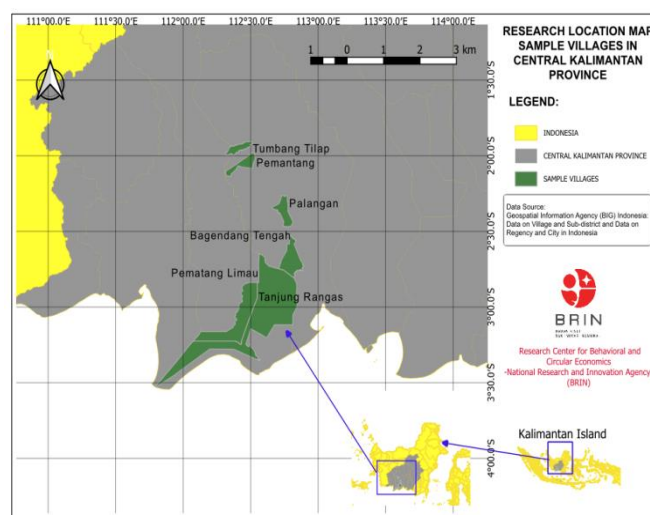


Figure 1. Locations of the sampled villages

3.2 Data collection

Respondents in this study were community members living in areas around oil palm plantations. Sample-size adequacy was considered based on the main aim of the research, namely, the examination of bivariate associations using Spearman's rank correlation coefficients. Bonett and Wright [53] stated that the size of the number of respondents required for correlation analysis should be considered based on the expected magnitude and level of precision of the desired correlation coefficient, not simply based on a generally accepted minimum sample size. A total of 147 respondents participated in the study, and this number met the empirical

basis for the correlational analysis carried out. Aimed to find the associations among oil palm farmers' perceptions of economic, sociocultural, and environmental aspects, a structured questionnaire was used to interview respondents to obtain primary data about their perceptions. Questionnaire items were developed based on the relevant literature reviewed in the preceding sections and were organized into three aspects: economic, sociocultural, and environmental. Each aspect comprised multiple items, as shown in Table 1. Sociodemographic characteristics of the respondents were also collected to describe the study population. These characteristics included age, gender, ethnic group, religion, place of residence, education, and number of dependents.

Table 1. Questionnaire items for each aspect and their supporting references

No.	Economic Aspect	Sociocultural Aspect	Environmental Aspect
1	The establishment of oil palm plantations has changed the community's primary sources of livelihood by creating new sources of income [37].	There have been changes in people's lifestyles since the establishment of oil palm plantations [25, 40].	There have been no significant changes to the landscape since the establishment of oil palm plantations [46, 54].
2	There are more job opportunities available near people's places of residence [37].	The construction of road infrastructure has improved transportation routes and access between places [25, 40].	There have been no natural disasters (floods, landslides, droughts) due to environmental damage [46, 54].
3	Household income or labor wages have increased since the establishment of oil palm plantations [37].	The availability of telecommunications and the internet has changed how people communicate [25, 40].	There are no water shortages or droughts in the surrounding area for daily needs [46, 54].
4	The community's economy has become more dynamic and productive since the establishment of oil palm plantations [37, 40].	The quality of people's housing has improved, with more houses becoming permanent [25, 40].	There is no decline, scarcity, or extinction of local plant or tree populations in the surrounding area [55].
5	Wages or profits earned are sufficient to meet current living costs [25, 37].	The availability of public or private latrines has improved community sanitation, making it cleaner and healthier [40, 41].	There is no decline, scarcity, or extinction of animal populations in the surrounding area [55].
6	The community is increasingly able to meet basic needs for clothing, food, and shelter since the establishment of oil palm plantations [25, 37].	The quality of public health has improved through immunization, vaccination, and medical treatment, resulting in reduced disease [40, 41].	There is no air pollution due to oil palm plantation activities [56].
7	Community spending patterns have changed since the establishment of oil palm plantations [40].	The quality of community education has improved, as reflected in the increasing number of school and university graduates [42].	There is no decline in land productivity for community agricultural cultivation and people can still farm [57].
8	The community's purchasing power has increased since the establishment of oil palm plantations [40, 58].	People's consumption patterns have become more consumerist in their shopping habits [40, 41].	There have been significant changes to the road infrastructure since the establishment of oil palm plantations in the area [39].
9	Asset ownership in the community has increased, indicating improved community welfare [40, 58].	The practice of shifting cultivation has decreased over time [43].	Communities are still able to utilize natural forest resources, including food, animals, and medicines, for daily use or for sale [55].
10	The community's economy is increasingly dependent on the existence of oil palm plantations [40, 58].	People still adhere to traditional cultural rituals and local wisdom in their daily lives [43].	—
11	The community has sources of income outside the oil palm plantation sector [40, 58].	Cultural traditions significantly influence people's daily lives through the application of customary law in the community [44, 45].	—
12	Most people in the community have employment or engage in income-generating activities [40, 58].	The community has become culturally diverse, with different cultures blending together [44].	—
13	—	The community has a communication forum for addressing horizontal conflicts between community members [44, 45].	—

3.3 Data analysis

The demographic characteristics of oil palm farmers were summarized using descriptive statistics. The Likert five-point scale was used to measure farmers' perceptions of economic, sociocultural, and environmental aspects in palm oil activities. Each of the aspects studied was represented by several statements. Consistent with previous studies assessing correlations among perception-related variables [59-61], this study also used a five-point Likert scale to rate responses: 5 = strongly agree, 4 = agree, 3 = undecided, 2 = disagree, and 1 = strongly disagree.

For each aspect, the responses to all corresponding items were summed to obtain a composite aspect score. Before correlation analysis was conducted, the internal consistency of the items within each aspect was evaluated using Cronbach's alpha coefficient [62]. Cronbach's alpha was calculated for the complete set of items within each aspect. This study used Cronbach's alpha for reliability measurement and examined whether removing an individual item substantially improved the internal consistency of the corresponding scale. This procedure was consistent with approaches adopted in previous perception-based studies [63, 64]. Associations among the

composite scores for the economic, sociocultural, and environmental aspects were subsequently evaluated using Spearman's rank correlation coefficient [65], which were consistent with previous studies examining relationships among perception-related variables [66-69].

4. RESULTS AND DISCUSSION

4.1 Demographic characteristics of respondents

In this study, 147 respondents from six sampled villages were included. The largest proportion of respondents was from Pematang (23.81%), followed by Pematang Limau (23.13%), Tanjung Rangas (21.09%), Palangan (13.61%), Bagendang Tengah (12.24%), and Tumbang Tilap (6.12%), as shown in Table 2. Regarding the number of dependents per household, 48.98% of respondents had three or fewer dependents, 42.18% had four to six dependents, and 8.84% had seven or more dependents. Respondents of 50-56 years old accounted for the largest proportion (21.77%), those of 71-77 years old accounted for the smallest proportion (2.72%), and those of 22-28 years old accounted for 14.29%.

Table 2. Demographic characteristics of respondents

No.	Demographic Characteristic	Category	Frequency (n)	Percentage
1	Village	Palangan Village	20	13.61%
		Pematang Village	35	23.81%
		Tumbang Tilap Village	9	6.12%
		Bagendang Tengah Village	18	12.24%
		Tanjung Rangas Village	31	21.09%
		Pematang Limau Village	34	23.13%
2	Number of Dependents	≤ 3 people	72	48.98%
		4-6 people	62	42.18%
		7 ≥ people	13	8.84%
		22-28	21	14.29%
		29-35	16	10.88%
		36-42	22	14.97%
3	Age (years)	43-49	30	20.41%
		50-56	32	21.77%
		57-63	15	10.20%
		64-70	7	4.76%
		71-77	4	2.72%
		Male	120	81.63%
4	Gender	Female	27	18.37%
		Dayak	111	75.51%
5	Ethnicity	Banjar	20	13.61%
		mixed	8	5.44%
		Others	8	5.44%
		Islam	104	70.75%
6	Religion	Hindu Kaharingan	22	14.97%
		Catholic	13	8.84%
		Protestants	8	5.44%
7	Education Level	Elementary school or equivalent	50	34.01%
		Junior high school or equivalent	33	22.45%
		High school or equivalent	48	32.65%
		Bachelor's degree	15	10.20%
		Master's degree	1	0.68%

In terms of gender, 81.63% of the respondents were male and 18.37% were female. Regarding ethnic group, the respondents were predominantly Dayak (75.51%), followed by Banjar (13.61%). Respondents of both mixed ethnicity (combinations of Dayak, Banjar, and Melayu) and other ethnic groups (such as Jawa, Melayu, and Madura) accounted for 5.44%, respectively. In terms of religion, respondents

believing in Islam accounted for 70.75%, followed by Hindu Kaharingan (14.97%), Catholic (8.84%), and Protestan (5.44%). In terms of educational background, elementary school or equivalent represented the largest proportion of respondents (34.01%), followed by high school or equivalent (32.65%), junior high school or equivalent (22.45%), bachelor's degree or equivalent (10.20%), and master's degree

or equivalent (0.68%). The ranking for religion and education in this study is also in line with BPS data for the entire Central Kalimantan Province [70].

4.2 Questionnaire reliability

The questionnaire items in Table 1 were abbreviated in Table 3 according to their respective aspects and item numbers. The economic aspect showed a Cronbach alpha coefficient of 0.84. When individual items were removed, the values did not fluctuate significantly. For example, when the 3rd item was removed, the value was 0.878; when the 10th or 12th item was removed, the value was 0.894, corresponding to a range of 0.016. The sociocultural aspect showed a Cronbach

alpha coefficient of 0.87. When individual items were removed, the values did not fluctuate substantially, ranging from 0.848 (with the 3rd item removed) to 0.881 (with the 12th item removed), representing a range of 0.033. The Cronbach alpha for the environmental aspect was 0.89. The values did not fluctuate significantly when individual items were removed, ranging from 0.811 (with the 5th item removed) to 0.846 (with the 1st item removed), representing a range of 0.035. Cronbach's alpha coefficients of 0.90 or higher have been reported [71-73], whereas coefficients in the range of 0.80 have also been reported [74-76]. Coefficients of about 0.70 are still considered reliable [77]. Table 3 shows the values of all aspects and their corresponding items, indicating satisfactory internal consistency of the questionnaire scales.

Table 3. Cronbach's alpha coefficients for each aspect and after individual item deletion

Aspect	Overall Alpha (95% Confidence Interval)	Item	Alpha If Item Deleted	95% Confidence Interval
Economic	0.84 (0.795–0.884)	Econ1	0.884	0.852–0.917
		Econ2	0.888	0.856–0.920
		Econ3	0.878	0.844–0.912
		Econ4	0.879	0.844–0.913
		Econ5	0.889	0.859–0.919
		Econ6	0.883	0.850–0.915
		Econ7	0.882	0.848–0.916
		Econ8	0.878	0.843–0.913
		Econ9	0.885	0.852–0.917
		Econ10	0.894	0.864–0.924
		Econ11	0.892	0.862–0.921
		Econ12	0.894	0.865–0.923
Sociocultural	0.87 (0.837–0.903)	Socul1	0.858	0.821–0.895
		Socul2	0.853	0.815–0.891
		Socul3	0.848	0.808–0.888
		Socul4	0.856	0.819–0.893
		Socul5	0.853	0.815–0.890
		Socul6	0.853	0.816–0.891
		Socul7	0.854	0.817–0.891
		Socul8	0.849	0.809–0.888
		Socul9	0.867	0.834–0.900
		Socul10	0.871	0.837–0.905
		Socul11	0.869	0.837–0.901
		Socul12	0.881	0.851–0.911
		Socul13	0.869	0.833–0.905
Environmental	0.89 (0.865–0.924)	Env1	0.846	0.802–0.890
		Env2	0.822	0.772–0.871
		Env3	0.825	0.778–0.872
		Env4	0.817	0.765–0.869
		Env5	0.811	0.755–0.866
		Env6	0.817	0.767–0.867
		Env7	0.816	0.765–0.866
		Env8	0.829	0.781–0.877
		Env9	0.825	0.778–0.872

4.3 Correlations among the three aspects

In general, the sociocultural aspect influences the perceptions of society or humans themselves, which then influences them to behave pro-environmentally or not [78]. In Jambi, indigenous communities depend on forest resources, particularly for food. The expansion of oil palm plantations has changed the traditional forest-resource management practices [79]. Meanwhile, Brenneis et al. [80] showed that communities living around oil palm plantations with direct contact with oil palm plantation activities exhibited more pro-environmental behavior compared to urban communities. Cisneros et al. [81] also found that political and economic incentives work in concert to cause forest loss and the conversion of land to oil palm (specially in pre-election time).

Yuliani et al. [82] compared people's perception and found individuals who were less connected to their communities, traditions, and the natural environment tended to convert forest to oil palm and prioritize short-term motivations, while those with stronger social and environmental connections tended to reject the idea and hold long-term motivations for forest conservation.

Village authorities serve as a bridge between various actor groups because they hold key, central, and well-connected positions in the information networks, highlighting the necessity of including these influential people in enhancing the governance of natural resources, like oil palm plantations [83]. Dominant narratives often unfairly blame smallholders for environmental problems while ignoring the involvement of corporations and state actors. Therefore, it is necessary to

consider the complex socioecological relationships among smallholders, communities, corporations, governments, and the natural environment [84]. In this current study, the Spearman's rank correlation coefficient for sociocultural and environmental aspects was found to be only 0.286 (Table 4).

Table 4. Spearman's rank correlations between the three aspects

Variables	n	Spearman's r_s	t-Statistic	p
Environmental and economic aspects	147	0.382**	4.98	< 0.001
Environmental and sociocultural aspects	147	0.286**	3.59	< 0.001
Economic and sociocultural aspects	147	0.726**	12.71	< 0.001

Note: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Economic conditions, such as income and employment status, are associated with pro-environmental behavior in various parts of the world [86]. Wijayanti [87] showed that, in communities around oil palm plantations, economic factors are one of the factors influencing pro-environmental perceptions. Nahlunniasa [88] identified a positive relationship between community perceptions and economic conditions, including income levels. Smallholders consider fertilization inputs not optimal economically and adopt intensive management practices to reach the highest yield in oil palm plots [89]. In Brazil, people still supported oil palm expansion after recognizing its negative impact on the environment because they prioritized employment opportunities and other economic benefits; their views were also shaped by land conflicts and plantation management practices [90]. Oliphant and Simon [91] found a similar case concerning the certification of palm oil mills. As for smallholders whose incomes depended on sales to the mills with Round-table for Sustainable Palm Oil (RSPO) certification, they faced the dilemma of choosing between investing additional time and incurring substantial costs to meet certification requirements or selling their produce to more distant mills offering lower prices. Fortunately, it was found that oil palm cultivation could be optimal economically without sacrificing the environmental aspect. On the contrary, mulching with empty fruit bunches not only increased soil organic carbon by 19% but also increased yields by 39% [92]. Similarly, compared with uncertified systems, Malaysian Sustainable Palm Oil (MSPO)-certified fresh fruit bunches produced by independent smallholders reduced overall environmental impacts while increasing profitability, with life cycle assessment indicating declines in almost all environmental impact categories. Further improvements were possible with the use of organic fertilizers. Life-cycle costing revealed about 39% higher net present value for MSPO-certified plantations over a 25-year period [93]. Meanwhile, Table 4 shows a statistically significant positive correlation between the economic and environmental aspects (0.382), consistent with previous studies. However, this coefficient represents a weak correlation according to the study by Schober et al. [85].

Oil palm plantations can change the livelihoods of surrounding communities. Community members, who previously worked as farmers with a high risk of income instability, have become workers in oil palm plantations with more predictable income, thereby increasing the purchasing power of the surrounding communities [94]. Siti-Dina et al. [95] examined the impact of oil palm plantations on surrounding communities in Malaysia and stated that the plantations have a direct impact on social change in the surrounding communities, which then facilitated economic

Even though it is statistically significant, indicating that the sociocultural and environmental aspect scores were positively associated, the strength of the relationship was weak according to the classification proposed by Schober et al. [85].

change as well through the availability of more sustainable employment opportunities. Euler et al. [96] stated that oil palm plantations have brought a sociocultural phenomenon. The plantations were found to have a significant positive effect on the economic development of surrounding communities and be associated with increased nutrition levels for oil palm adopters. In addition, villages switching to oil palm monoculture benefited economically when they had prior experience with polyculture plantations and plantation management and market-based economic activities. However, for those whose livelihoods had depended on farming, foraging, and fishing, their economic benefits of conversion to monoculture persisted for only a few years, after which community welfare deteriorated [40]. In Brazil, RSPO certification has reshaped local institutions and family farming under the corporate contract farming model. Tensions concerning land titles and labor rules have created barriers to farmer participation, disrupted traditional family labor practices, and highlighted the challenges of aligning global sustainability standards with strict but unevenly enforced national regulations [97]. In this current study, a significant positive correlation between the economic and sociocultural aspects was identified. The correlation coefficient was 0.726 (Table 4), representing the strongest correlation observed among the aspects examined in this study. According to the study by Schober et al. [85], this coefficient indicates a strong correlation, which reinforces the results of previous studies.

5. CONCLUSION

The main purpose of this research was to examine the correlations among sociocultural, economic, and environmental perceptions of local communities residing in areas surrounding oil palm plantations in Central Kalimantan Province. The internal consistency of the questionnaire was assessed using Cronbach's alpha. Values exceeding 0.80 were obtained for each aspect, including the values obtained by removing individual items, indicating good internal consistency of the measurement instrument. Spearman's rank correlation analysis was conducted to examine the relationships among the three aspects. Varied strengths of correlation were found. The correlation between the economic and sociocultural aspects was strong (0.726), followed by that between the economic and environmental aspects (0.382) and that between the sociocultural and environmental aspects (0.286). This study not only reveals the statistically significant correlations among the sociocultural, economic, and environmental aspects but also provides preliminary evidence regarding the strength of the interrelationships among these dimensions in communities surrounding oil palm plantations.

In addition, this study contributes to the development of a preliminary measurement scale for these aspects. This measurement may also serve as a useful foundation for future research aimed at further validating, refining, and extending the measurement framework among oil palm-related communities in Indonesia and across different geographical, demographic, and institutional contexts.

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