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Developing Social Indicators for Farming Social Life Cycle Assessment in North Sumatra

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ABSTRACT

The social sustainability impact of the Food Estate Program has been the subject of extensive research, providing an evaluation assessment of social, economic, and environmental aspects. However, there has been a paucity of research examining the farmers surrounding the Food Estate Program in greater detail, especially regarding its social impacts. The present study employs the Social Life Cycle Assessment (S-LCA) to analyze the social impacts. The S-LCA is a methodological approach that utilizes primary data from various stakeholders, including farmers, governments, farmer groups, and the broader community. The objective of this study is threefold: first, to ascertain the social criteria employed to evaluate the social impact of strategic commodity farming; second, to examine the experiences and expectations of stakeholders concerning farming activities from a social perspective; and third, to identify the aspects of social sustainability in strategic commodity farming. The findings indicate that the social impact category that exerts the most significant influence on agricultural practices is that of socio-economic factors. Of the five social impact categories, only human rights and socio-economics demonstrate conditions that surpass the expected range. To achieve social sustainability, stakeholders in the strategic commodity farming system must collaborate to establish effective governance.

Keywords: Farming, Food Estate, Social-Life Cycle Assessment, Sustainability

INTRODUCTION

As a social creature, farmers frequently engage in interactions with each other. They exchange information, knowledge, and experiences. Each interaction is conducted in accordance with local values and norms. Farming involves not only economically driven activities aimed at earning a profit, but also socially related activities due to its impact on society.

Social aspects influenced by farming include social equality (Arenas et al. 2024), educational level (Takagi et al. 2024), and community health (Gripper and Cowger 2025). Takagi, Saijo, and Ohashi (2025) noted that farming can help improve people's education level. Farmers with higher incomes tend to have better health (Song et al. 2022). However, they need equal access to social welfare.

Economic orientation should be applied in farming by the majority of

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farmers in Indonesia. However, many farmers still face social issues in running their farms. Consequently, they struggle to implement economic orientation.

One of the social issues faced by many farmers is unequal access to resources and trust, isolating them from their community (Yusriadi 2025). Only certain farmers can have such access. Furthermore, other farmers lack social solidarity, which hinders their ability to achieve economic goals. The dominance of only a few local actors can trigger social inequality (Kuntariningsih, Santoso, and Mariyono 2023).

Limited access to farming resources, including training and socialization, has a significant impact on farmers' quality of life. Nisak, Prayitno, and Dinanti (2025) argued that limited access to training and public enlightenment is primarily due to farmers' lack of capital, which constrains them to conventional farming activities. Unequal access to knowledge directly affects farmers' ability to innovate and improve their quality of life.

Theoretically, farming activities are inextricably linked to social, cultural, and local aspects, commonly referred to as embeddedness, introduced by van der Ploeg in 2008. This concept views farmers not only as objects of development, but also as active actors who shape society and culture in order to survive in constantly changing economic systems (van der Ploeg 2013). While economic demands are increasing, the social aspects of farming should not be neglected.

The Indonesian government has implemented numerous, yet economically driven, efforts to address farming issues. As reflected in regulations and policies, the government has overlooked social aspects, leading to a degradation of social and cultural values due to market pressure and modernization. Market pressure leads to a dramatic increase in strategic commodity demands, requiring both off-farm and on-farm strategies to meet those demands.

In response to this, the government designed a program called Food Estate (FE). This program was developed during the New Order era under a different name, but it retains the same concept and primary goal: to increase agricultural production on a large scale. In 2020, President Joko Widodo launched this program in Humbang Hasundutan Regency in North Sumatra Province, an area developed for FE. Initially, this area was developed for the cultivation of strategic horticultural crops, including shallots, garlic, and red chillies (Kementan 2020).

A study examining the sustainability of the FE program in North Sumatra found that it scored 50% for social sustainability and 33.33% for the cultural aspect (Juhandi et al. 2023). FE refers to a large-scale farming that requires strategies for cultivating the land, particularly in addressing issues related to land ownership rights, which are currently happening in society. The social sustainability of the FE program is influenced by the land rent system and profit-sharing mechanism (Juhandi et al. 2024). Social issues related to land use are faced not only by FE farmers but also by the majority of farmers in Indonesia.

The FE program has raised critical questions, such as what will happen to farmers who are not given the opportunity to participate and whether they will receive equal access to agricultural resources and public enlightenment. Those questions need to be addressed to raise awareness of farmers' conditions. Further reviews of farmers' social conditions are also necessary to promote fair and equal access to agricultural resources. Although not participating in the FE program, all farmers should be considered, as they also produce strategic commodities essential for national food security and sustainability. More importantly, research should also be

conducted on the sustainability of farming strategic commodities, such as red chillies and shallots.

Setiadi et al. (2021) stated that social factors, such as motivation, technology adoption, and commitment, contribute to the sustainability of farming. The most recent S-LCA study, conducted by Dunuwila et al. (2025), is limited to a single commodity and has been generalized to the entire agricultural sector, despite not being tested across different contexts. It highlights the importance of further research on the social aspects of sustainability. On the other hand, the S-LCA study by Mulyasari et al. (2023) remains limited to a qualitative approach, lacking statistical weighting and robust quantitative validation. Other limitations of previous S-LCA studies are related to data analysis and generalization, which have prompted the adoption of a more specific and quantitative approach to examine the social aspects of strategic commodity farming in Indonesia.

Many studies have been conducted to investigate the impacts of the FE program on social sustainability, including Silalahi, Yuliana, and Iskandar (2023), who assessed the conditions and participation of the FE farmer community. Social, economic, and environmental impacts have also been explored through the lens of Systematic Literature Review (SLR) by Fatahullah and Hilmi (2024). The latest study by Risdianto, Felix Marshal Jotham, and Nurdin (2024) examined the social, economic, and environmental impacts of the FE program; however, it did not collect primary data and did not present quantitative data. Other previous studies have not investigated the impact of the program on nearby farmers who are excluded from the program. Thus, this study was conducted to examine the impact of the FE program on nearby farmers excluded from the program, using the S-LCA method, primary data, and a quantitative descriptive approach. Data were collected from various stakeholders, including government officials, farmer groups, local communities, and individual farmers. This study aims to (1) identify the social criteria used to assess the social impact of strategic commodity farming in Humban Hasundutan Regency, (2) analyze the stakeholders' experiences and expectations in farming activities from a social perspective, and (3) examine the aspects of social sustainability in strategic commodity farming, as experienced and expected by all stakeholders.

METHOD

Research Method

This study employed a quantitative descriptive approach to describe the research phenomenon, analyze the data, and interpret the results. The Social Life Cycle Assessment (S-LCA) was adopted to identify the social impact on farmers who cultivate strategic commodities, such as shallots and red chillies. Both vegetables are national strategic commodities (Kementan 2023, 2024).

Research Location

Humbang Hasundutan is a regency with two main commodities: shallots and red chillies (Juhandi and Purba 2021). This study was conducted in three subdistricts: Lintong Nihuta, Doloksanggul, and Pollung, where the central producers of shallots and red chillies are located.

Data Types

This study used primary data to assess the social aspects of farming. Primary data are typically used to describe human rights, working conditions, cultural heritage, socio-economic impacts, and governance. Data were measured using a 7-point Likert scale. To measure expectations, the scale ranged from very unimportant, unimportant, quite unimportant, neutral,

quite important, important, and very important. Meanwhile, to measure perceptions, the scale ranged from strongly disagree, disagree, quite disagree, neutral, quite agree, agree, and strongly agree.

Table 1
Strategic Commodity Production in Humbang Hasundutan Regency

Regency	Production (ton)	
	Red Chillies	Shallots
Pakkat	13.4	0
Onan Ganjang	28.2	27.8
Sijamapolang	48.4	19.15
Doloksanggul	**136.5**	**129.8**
Lintong Nihuta	**127.9**	**124.8**
Paranginan	59.1	50.25
Baktiraja	7	20.69
Pollung	**138.2**	**150.4**
Parlilitan	32.9	18
Tarabintang	0	0

Source: (BPS 2025)

Table 2
Impact Categories, Criteria, and Labels

Impact Categories	Criteria	Label
Human right	Free from the employment of child labor	A1
	Free from the employment of forced labor	A2
	Equal opportunities, free from discrimination	A3
Working conditions	Freedom of association and collective bargaining	B1
	Fair salary	B2
	Decent working hours	B3
	Occupational health and safety	B4
Cultural heritage	Land acquisition, delocalization, migration	C1
	Respect on cultural heritage and local wisdom	C2
	Respect on customary right of indigenous people	C3
	Community engagement	C4
	Safe and healthy living condition	C5
	Transparency on social and environmental issues	C6
Socio-economic repercussion	Contribution to local employment	D1
	Contribution to economic development	D2
	Food security	D3
	Horizontal conflict	D4
	Transfer of technology and knowledge	D5
Governance	Public commitments to sustainability	E1
	Fair competition	E2
	Free from corruption	E3
	Reduced poverty	E4

Source: Processed Primary Data, 2024

Table 3
Criteria of Assessments and Respondents

Criteria	Stakeholders			
	Farmers	Community	Local People	Farmer Groups
A1 - A3	V			
B1 - B4		V	V	
C1 - C6		V		
D1 - D5	V			V
E1 - E4				V

Source: Processed Primary Data, 2024

Data Sources

Data were collected from the stakeholders involved in the agricultural system, including farmers, local government officials, local communities, and local people. The sampling technique was employed. Therefore, the total number of respondents was 55, including 25 farmers, 3 local government officials, 2 local communities, and 25 local people.
The farmers were from three subdistricts and were recruited as respondents using a purposive sampling technique. The criteria for selecting the respondents were as follows: (1) farmers from one of three predetermined subdistricts; (2) farmers cultivating either shallots or red chillies, and (3) farmers who do not participate in the FE program

Data Collection

A questionnaire was administered to the respondents. It consisted of closed-ended questions with answer choices based on a predetermined Likert scale. The researchers asked the respondents about social impacts and recorded their responses directly on the answer sheets.

Data Analysis

The criteria for social impacts used in this study were adopted from the Society of Environmental Toxicology and Chemistry (SETAC)/ the United Nations Environment Programme (UNEP). Experts participated in this survey to decide the weight of each criterion. They were selected based on their experiences in farming sustainability and asked to rank each criterion using a questionnaire. During data collection, the experts completed the questionnaire in an online form. They compared each criterion using a 1-9 scale, where 1 indicates equal importance, 3 indicates moderate importance of one criterion over another, 5 indicates strong importance, 7 indicates very strong or demonstrated importance, and 9 indicates extreme importance of one criterion over another. Even-numbered values (2, 4, 6, and 8) indicate that the importance lies between two adjacent levels. The results of the criteria development and weighting process led to the classification of 22 social criteria into five categories of social impacts: human rights, working conditions, cultural heritage, socio-economic repercussions, and governance.

Variable Measurement

This study analyzed five variables of social impact, including human rights, working conditions, cultural heritage, socio-economic repercussions, and governance. The assessment of the human rights variable used three criteria (A1-A3), the working conditions variable used four criteria (B1-B4), the cultural heritage variable used six criteria (C1-C6), the socio-economic repercussion variable used five criteria (D1-D5), and the governance variable used four criteria (E1-E4). The experts decided on the weighting of all variables and each criterion.

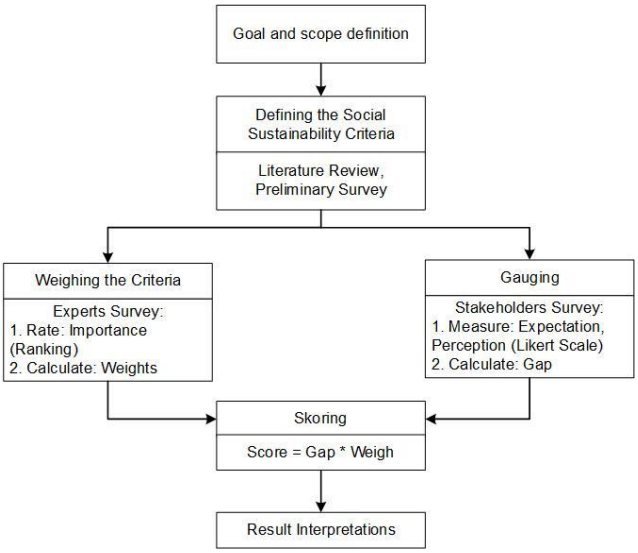


Figure 1.
Stages of Data Analysis

RESULTS AND DISCUSSION

Social Criteria in Assessing Social Impacts of Farming Activities

Table 4 shows the results of the social criteria used to assess the social impacts of farming, obtained by asking the stakeholders to evaluate each criterion. The results indicate that among the five categories, the socio-economic repercussion has the highest scale weight. The criterion of human rights with the highest scale weight is the equal opportunities for employment (A3). The criteria with the highest scale weight for working conditions are fair salary (B2) and occupational health and safety (B4). The criterion of cultural heritage with the highest scale weight is the transparency on social and environmental issues (C6). For the socio-economic repercussion, the criteria with the highest scale weight are the contribution to economic development (D2) and food security (D3). Meanwhile, the criterion of governance with the highest scale weight is free from corruption (E3).

Equal opportunities for employment are an important matter, particularly in relation to gender equality in farming activities. Fertő and Bojnec (2024) argued that women play a significant role in the sustainability of farming activities. Equal opportunities for women promote social inclusion, which in turn helps achieve sustainable food security. Equal opportunities for employment are crucial in achieving socio-economic sustainability (Kumari et al. 2025).

Development International (2022) stated that fair salaries contribute to economic justice and the resilience of farmer groups, as well as promote empowerment through a collective strategy. On average, farm workers in Indonesia earn 58,445 rupiahs per day (Badan Pusat Statistik 2022). This contributes to the declining interest of young people in agriculture in Indonesia (Ngadi et al. 2023). In addition to salary, another important criterion is occupational health and safety for farmers. Health and safety are basic needs for farmers to perform farming activities, thereby reducing long-term socio-economic burdens (Dedieu et al. 2022).

Table 4
Impact Categories, Criteria, and Labels

Impact Categories	Weight	Label	Weight	Overall weight
Human rights	0.060	A1	0.300	0.029
		A2	0.333	0.032
		A3	0.367	0.035
			1.000	0.096
Working conditions	0.150	B1	0.160	0.026
		B2	0.320	0.051
		B3	0.200	0.032
		B4	0.320	0.051
			1.000	0.161
Cultural heritage	0.130	C1	0.105	0.035
		C2	0.076	0.026
		C3	0.133	0.045
		C4	0.190	0.064
		C5	0.229	0.077
		C6	0.267	0.090
			1.000	0.338
Socio-economic repercussion	0.380	D1	0.227	0.055
		D2	0.253	0.061
		D3	0.253	0.061
		D4	0.173	0.042
		D5	0.093	0.023
			1.000	0.241
Governance	0.280	E1	0.255	0.042
		E2	0.176	0.029
		E3	0.392	0.064
		E4	0.176	0.029
			1.000	0.164

Source: Processed Primary Data, 2024

Social sustainability needs to consider transparency regarding social and environmental issues, as it is key for facilitating accountability, building trust between stakeholders, and complying with sustainability regulations (Steiner, Makarenko, and Yuhai 2024). As highlighted by Magnano, Falasconi, and Giordano (2024), social transparency is crucial in the S-LCA for a fair and sustainable agricultural system.

Contributions to economic growth and food security also require attention. Hiywotu (2025) noted that to increase productivity and economy, farmers need to strengthen their household economic resilience in order to build long-term socio-economic resilience. To achieve this, social capital is necessary in fostering economic growth and food security (Rusmawati, Hartono, and Aritenang 2023)

In the governance of farming systems, freedom from corruption is critical. Corrupt practices, such as extortion and market politicization, damage social structures, break the stakeholders' trust, and hinder justice for farmers (Demeshko et al. 2024) Tacconi and AledWilliams (2020) asserted that such activities can have direct social implications, such as poverty, land-access-related conflicts, and unfair distribution of agricultural resources.

Gap Analysis of Social Perspectives in Farming Activities

Table 5 illustrates the gap between shareholders' expectations and perceptions of the social impacts of farming activities. Expectations refer to farmers' social perspectives on the expectations of each impact category, while perceptions are social perspectives on the real conditions of each impact category.

Table 5
Expectations, Perceptions, and Gaps of Social Impacts of Farming Activities

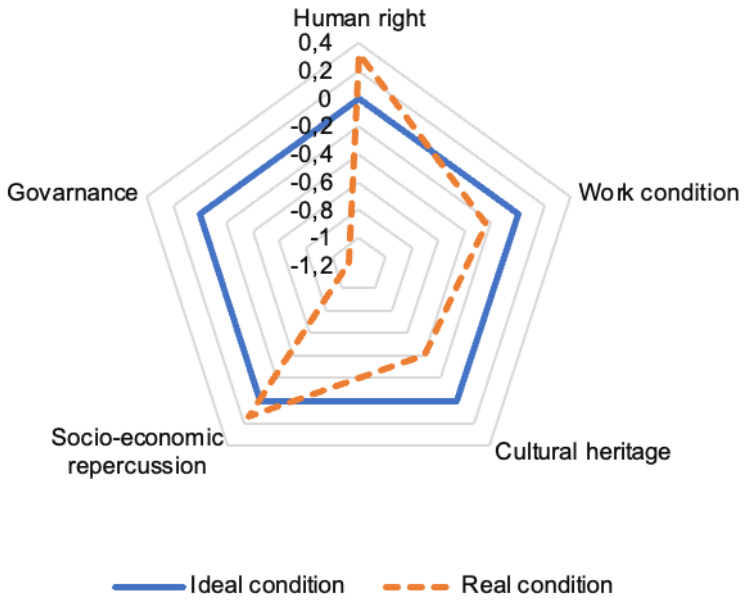
Impact Categories	Label	Expectation	Perception	Gap-*Mean*	Gap-SD
Human rights	A1	5.36	5.56	0.20	0.14
	A2	5.36	6.12	0.76	0.54
	A3	5.96	5.96	0.00	0.00
Working conditions	B1	6.28	6.24	-0.04	0.03
	B2	6.28	5.88	-0.40	0.28
	B3	6.32	5.96	-0.36	0.25
	B4	6.52	6.36	-0.16	0.11
Cultural heritage	C1	5.80	5.36	-0.44	0.31
	C2	6.20	5.76	-0.44	0.31
	C3	6.44	6.08	-0.36	0.25
	C4	6.28	5.80	-0.48	0.34
	C5	6.60	6.08	-0.52	0.37
	C6	5.88	5.72	-0.16	0.11
Socio-economic repercussion	D1	6.00	6.33	0.33	0.24
	D2	6.00	6.33	0.33	0.24
	D3	6.33	6.67	0.33	0.24
	D4	5.67	5.33	-0.33	0.24
	D5	6.00	6.33	0.33	0.24
Governance	E1	6.50	6.00	-0.50	0.35
	E2	7.00	4.50	-2.50	1.77
	E3	7.00	6.50	-0.50	0.35
	E4	7.00	6.00	-1.00	0.71

Source: Processed Primary Data, 2024

Social Sustainability Aspects of Farming Activities

Figure 2 shows the average gap for each impact category, obtained from a survey on stakeholders' perspectives in farming activities. Additionally, the results of each criterion provide further information. The straight line in the graph indicates that the actual experiences align with the expectations (the gap is 0, representing the ideal condition). Meanwhile, the dotted line describes the stakeholders' perspectives during this study. It can be clearly seen that only two impact categories exceed expectations: human rights and socio-economy.

In contrast, working conditions, cultural heritage, and governance have greater gaps than other categories. Overall, the gap weight of each criterion is -0.27. These results suggest that the overall perceptions of stakeholders regarding the social impacts of the farming system are significantly lower than their expectations.



Source: Processed Primary Data, 2024

Figure 2.
Social Sustainability Aspects of Farming Activitie

Human Rights

The average gap in the human rights category is 0.32. There is a significant difference between expected and experienced conditions. The results of this study found no major problems with the three human rights indicators in farming, including child employment, forced labour, and discrimination in farming activities. The farmers in the research area generally hire more professionally paid non-family labor for each cultivation stage, so child labor, forced labor, and wage discrimination are rarely found. As a result, the business in farming incurs labor costs, which increase variable costs.

Working conditions

The working conditions experienced by farmers did not meet their expectations, with actual experiences being poorer than expected by an average gap of -0.24. Freedom of association and collective bargaining (B1), fair salary (B2), decent working hours (B3), and occupational health and safety (B4) in farming activities. Without freedom of association and collective bargaining, small-scale farmers will struggle to access collective bargaining and improve their health (Malanski et al. 2022). This aspect plays a crucial role in preventing exploitation and providing a platform for negotiations on decent working conditions. In addition, collective organizations can strengthen social investments, such as training, health, and social security. This study found that a wage gap exists between female and male laborers. Female laborers are paid slightly less than male laborers. It is caused by the different types of work performed, even though the work hours are the same. For instance, female laborers typically harvest crops, while male laborers work on land processing and plant maintenance.

Cultural Heritage

Similarly, there is a gap between farmers' experiences and expectations of cultural heritage, with an average score of -0.40. This result indicates that the actual experiences in cultural heritage are poorer than the expectations. The cultural heritage category consists of: suitability of additional land for farming activities (C1); respect for cultural values in farming (C2); respect for customary values of indigenous people in farming (C3); consideration of community engagement in farming activities (C4); attention to health and safety in farming (C5); and transparency into social and environmental issues (C6). Assessments on the social impacts of farming should consider cultural heritage, as farmers observe and apply local values and norms in performing farming activities. Elnaggar (2024) argued that social dimensions, such as cultural heritage, are currently developing in assessing the impacts of the productive economic sector. This aspect needs to be assessed in farming activities to ensure the accuracy of social evaluation and sustainability within the local context (Capdevila 2021). Assessing the impacts of cultural heritage on farming activities can reinforce social cohesion and legitimize farming practices, prioritize cultural heritage values when adopting new technologies, and preserve cultural heritage for future generations. The young generation involved in the agricultural sectors in the research area is still limited, so cultural values will be difficult to preserve, as they are generally rooted in older farmers.

Socio-Economic Repercussion

Social and economy, commonly referred to as socio-economics, are two inseparable aspects. The gap score of this impact category is 0.14, indicating that the experiences are more favorable than the expectations. The criteria of this category include: the contributions of farming activities to local employment (D1), the contributions of farming activities to economic growth (D2), farming activities for food security (D3), absence of horizontal conflicts when performing farming activities (D4), and transfer of knowledge and technology for farming activities (D5). The conflict between farmers rarely happens in the research areas, so the social relations between society are conducive. The condition is ideal for supporting economic activities such as farming. Despite the absence of conflicts in the socio-economic impact, a crucial aspect that previous studies have highlighted is the role of public enlightenment. It should provide consulting and guidance services to enhance farmers' productivity and welfare; thus, its organizational structure should be improved to have a greater impact on farmer groups (Sundari et al. 2021).

Governance

Governance has an average gap score of -1.13. This indicates that the actual experiences differ from the expectations. The gap was experienced in the following criteria: public commitment to farming sustainability (E1), fair competition in farming activities (E2), farming activities free from corruption (E3), and farming activities aimed at reducing poverty (E4). The limited land available to farmers makes it difficult for them to scale up their farming operations. It leads to limited income, so poverty in the agricultural sectors of the research area is challenging to address. Governance in farming activities requires active collaboration between farmers and the government. However, the study's results revealed that governance in the farming system failed to meet expectations. This may result from the insufficient trust and collaboration between farmers and the government to enhance social productivity (Mariyani and Suciati 2021). Romadi et al. (2021) noted that this problem can be addressed by

reinforcing social participation and legitimizing the program, promoting a sense of belonging, and overcoming inequality of access to agricultural information and innovation.

CONCLUSION

The results of the study showed that socio-economic factors have the most significant influence on the strategic commodity farming system. Regarding human rights and socio-economics, no problems were found in the farming system, as actual experiences were more favourable than expected. However, the working conditions, cultural heritage, and governance fell short of expectations. The social sustainability aspects of strategic commodities remain relatively weak and fall short of stakeholders' expectations. This suggests that governance, working conditions, and cultural heritage need to be balanced to achieve sustainable farming. This study recommends that the government strengthen collaborations with communities and farmers to build trust as a form of social capital in farming system governance. Furthermore, the development of new technologies should continue to respect local values and cultures that have long existed and evolved within the community.

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