P-ISSN 0853-2885
E-ISSN 2685-3345

Risk Mitigation for Cattle - Oil Palm Integration Farming (SISKA) in West Kalimantan Province

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INFO ARTIKEL

Diterima: 24-03-2025
Direvisi: 04-06-2025
Dipublikasi: 14-08-2025

Keywords:
Integrasi, Kelapa sawit, Mitigasi risiko, Sapi, SISKA

Kata Kunci:
Cattle, Integration, Palm oil, Risk mitigation, SISKA

ABSTRACT/ABSTRAK

Mitigasi Risiko Sistem Integrasi Sapi – Kelapa Sawit (SISKA) di Provinsi Kalimantan Barat

Sistem integrasi sapi - kelapa sawit (SISKA) merupakan salah satu strategi yang dapat meningkatkan ketercapaian beberapa *Sustainable Development* Goals (SDG's) dan dapat mengurangi risiko *Indirect Land Use Change* (ILUC). Salah satu permasalahan pengembangan SISKA adalah rendahnya minat peternak sapi di sekitar wilayah perkebunan sawit yang diduga disebabkan oleh kurangnya pengetahuan peternak sapi dalam manajemen risiko. Penelitian mengenai sistem integrasi sapi – kelapa sawit telah banyak dilakukan, namun penelitian mengenai mitigasi risiko belum banyak dianalisis secara komprehensif. Penelitian dilakukan pada bulan Februari - Mei 2024. Populasi dari penelitian ini adalah ketua dan anggota dari empat kluster SISKA (Meso Tani, Dekan Jaya, Rimba Makmur, dan Subur Kampit) di Kabupaten Sanggau, Provinsi Kalimantan Barat dengan jumlah responden sebanyak 30 orang. Model *House of Risk* digunakan untuk mengidentifikasi dan memitigasi risiko pada penelitian ini. Hasil penelitian ini menunjukkan bahwa terdapat tiga dari tujuh sumber risiko yang perlu diprioritaskan untuk ditangani, yaitu pengendalian gulma oleh perusahaan dengan menggunakan herbisida, sapi masuk ke lahan *replanting*, dan perkawinan sedarah. Penelitian ini menghasilkan tiga strategi untuk penanganan agen risiko, yaitu penggunaan pagar listrik, penerapan sistem penggembalaan bergilir, dan pengadaan sapi jantan unggul.

Cattle-oil palm integration (SISKA) is one strategy that can improve several achievements of the Sustainable Development Goals (SDGs) and reduce the risk of indirect land use change (ILUC). One of the problems with SISKA development is the low interest of cattle farmers in areas surrounding oil palm plantations, which is attributed to a lack of knowledge among cattle farmers regarding risk management. There have been many studies on cattle-oil palm integration systems, but research on risk mitigation has not been comprehensively analyzed. The research was carried out between February and May 2024. The population of this study consisted of the heads and members of four SISKA clusters (Meso Tani, Dekan Jaya, Rimba Makmur, and Subur Kampit) in Sanggau District, West Kalimantan Province, with a sample size of 30 individuals. This study used the House of Risk model to identify and mitigate risks. The research results showed that three of seven risk sources must be prioritized and addressed, namely, weed control using herbicides by the company, cattle entering replanting land, and inbreeding. This study resulted in three strategies for handling risk agents, namely the use of electric fences, the implementation of a rotational grazing system, and the procurement of superior bulls.

INTRODUCTION

Food security has emerged as an important pillar of the national economy, with the potential to drive Indonesia's economic growth (Fernandes & Samputra, 2022; Hartono *et al.*, 2023). This security is achieved through consistent domestic food production. The main aspect of food security is self-sufficiency (Gubarkov *et al.*, 2021), which is measured by the ability of domestic food production to meet 90% of demand (FAO, 2009). One of the food commodities in Indonesia that has not been able to meet demand is beef production. Domestic beef production currently only meets 60% of demand, and this deficit is projected to continue until 2027 (Bremer *et al.*, 2022; Chafid, 2023), a situation that should raise serious concerns.

The strategy undertaken by the Government of Indonesia to realize self-sufficiency in beef commodities is to develop a palm-cattle integration system (HDPKH, 2024). Implementing a cattle-oil palm integration system is an appropriate strategy to meet national beef demand from domestic production by 2034,with a grazing area in oil palm plantations of 2,150,000 ha (Pinardi *et al.*, 2020). The implementation of the cattle-oil palm integration system in Indonesia will have an impact on accelerating the improvement of SGDs in Indonesia, including no poverty, zero hunger, responsible consumption and production, and climate action because it can fulfill beef demand (Bremer *et al.*, 2022), increase income per hectare of oil palm farmers by upto 15 percent because it can increase oil palm production and weed control cost efficiency (Setiawan *et al.*, 2024), reduce herbicide use and improve soil quality (Umar *et al.*, 2023), and reduce the risk of ILUC due to oil palm plantations (Grinnell *et al.*, 2022; Álvarez *et al.*, 2024). The development of the oil palm-cattle integration system is based on the potential oil palm plantation area in Indonesia. Indonesia is the largest CPO producer, with the largest oil palm plantation in the world at 16,380,000 ha (Zhao *et al.*, 2024; Descals *et al.*, 2024). Oil palm plantations have the potential asa source of feed for cattle, such as vegetation on plantation lands such as various types of grass and legumes (Hanum, 2023), by-products from oil palm plants, and the palm oil processing industry such as palm fronds, empty palm bunches, palm fiber, and palm meal (Yusriani *et al.*, 2021). Four provinces in Indonesia have been identified as suitable locations for the development of the Cattle- Oil Palm Integration System (SISKA) based on their potential for oil palm plantations: Riau, West Kalimantan, South Kalimantan, and East Kalimantan (SCRD, 2024b). To support the effective implementation of SISKA in these areas, clusters were formed consisting of farmer groups that adopted the SISKA model and cooperated with oil palm companies in each province (Darsono, 2023a).

Since its inception in 2021, the SISKA program has not developed significantly. This is evident from the fact that the number of SISKA clusters has remained unchanged since 2023-2024 and has tended to decline (SCRD, 2023; SCRD, 2024a). This indicates that the development of the cattle-oil palm integration system has not been optimal (Ilham *et al.*, 2021). The stagnant number of SISKA business actors is attributed to a lack of knowledge among cattle breeders and independent smallholders regarding the business risks associated with cattle-oil palm integration. Insufficient non-formal knowledge has negatively impacted farmers' interest in expanding their livestock (Khairi, 2021). However, an improved understanding of livestock business risks could enhance smallholder farmers' interest in scaling up their operations (Manyike *et al.*, 2025; Mastuti *et al.*, 2025).

While there has been extensive research on the cattle-palm integration system, including on the potential of SISKA (Grinnell *et al.*, 2022), the impact of SISKA implementation (Álvarez *et al.*, 2024), the characteristics and problems of SISKA (Silalahi *et al.*, 2018; Chang *et al.*, 2020; Bremer *et al.*, 2022), SISKA development strategy (Paggasa & Abdillah, 2022), and SISKA feasibility analysis (Sari & Silalahi, 2022), a critical gap remains in the comprehensive analysis of risk mitigation in cattle-palm integration systems. This gap is of utmost importance and requires immediate attention.

Risks in livestock businesses can result in significant financial losses if not adequately mitigated.

Jurnal Agrikultura 2025, 36 (2): 383 - 393
P-ISSN 0853-2885
E-ISSN 2685-3345

Climate change has heightened risks in cattle farming, impacting feed production, water availability, and the spread of livestock diseases, which can increase losses for smallholder farmers (Astaman *et al.*, 2022; Mastuti *et al.*, 2025). Unaddressed risks can lead to additional challenges (Komarek *et al.*, 2020). The inability of farmers to manage risks related to feed, equipment, income, and livestock health can have serious consequences (Adepoju & Osunbor, 2018). Therefore, this study aims to identify risks and formulate risk mitigation strategies in cattle-oil palm integration, providing comprehensive knowledge of the business risks of cattle-oil palm integration systems.

MATERIALS AND METHODS

Description of the study area and time

This research was conducted in Sanggau District, West Kalimantan Province (Figure 1). West Kalimantan is the second-largest province for palm oil plantations in Indonesia (BPS, 2024) and has the second-highest number of SISKA clusters (SCRD, 2024b). Sanggau District is the second largest district in terms of forage resource area in West Kalimantan Province (Salim *et al.*, 2023), with the highest number of SISKA clusters (SCRD, 2024b). This study was carried out between February and May 2024.

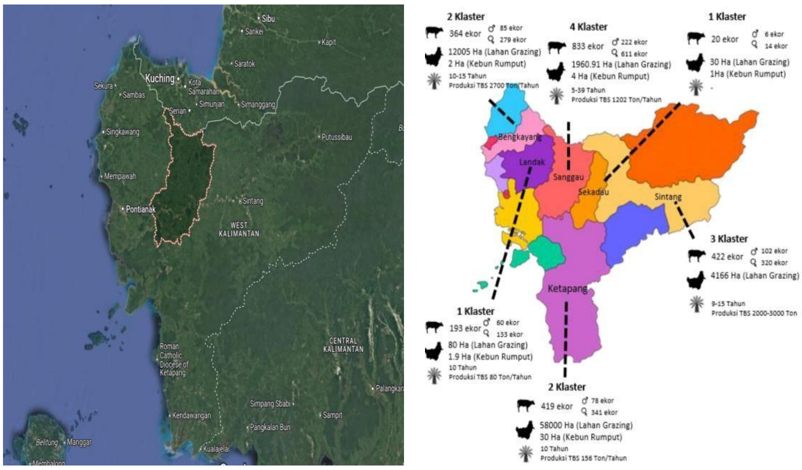

Figure 1. Location of the study

Selection of interview participants

The participants of this study were heads and members of four SISKA clusters in Sanggau Regency (Meso Tani Cluster, Dekan Jaya Cluster, Rimba Makmur Cluster, and Subur Kampit Cluster). The number of respondents was 30, who were selected using a purposive sampling method. A limited sample size, such as 30, may prove to be adequate for a homogenous group or when the research question is relatively simple (Makwana *et al.*, 2023). The selection of respondents was based on the length of experience of raising livestock with the cattle-oil palm integration system (above five years) and being a source of information for actors of the cattle-palm oil integration system in Sanggau District (Astuti *et al.*, 2018).

Data Collection

This research employed a mixed method with an exploratory type, starting with qualitative research and progressing to quantitative research (Pane *et al.*, 2021). The qualitative phase was dedicated to identifying risks in the cattle-palm oil integration system, while the quantitative phase was used to measure risks, map risks, and determine risk mitigation strategies. Risk identification in this study was focused on the production and marketing aspects, as these aspects significantly impact the cattle business (Astaman *et al.*, 2022). The primary data were collected from respondents using questionnaires adapted to the House of Risk (HOR) framework, a robust and reliable tool for risk assessment (Astuti *et al.*, 2018; Parenreng *et al.*, 2019; Purnomo *et al.*, 2021) as presented in Table 1. Secondary data was sourced from the Plantation and Livestock Service of West Kalimantan Province, the Association of Actors and Observers of the Cattle-Oil Palm Integration System, and journal articles. The data obtained from the questionnaire results regarding risk frequency and impact are then grouped, which in this study is based on a Likert scale of 1-5 (Purnomo *et al.*, 2021; Lengyel *et al.*, 2023).

Table 1. Risk Frequency and Impact Measurement Criteria

Scale	Description of Risk Frequency	Description of Risk Impact (IDR)
5	Nearly certain to occur	Loss value over 10.000.000
4	Highly likely to occur	Lose value between 5.000.000 – 10.000.000
3	May occur	Lose value between 2.500.000 – 4.900.000
2	Not likely to occur	Lose value between 1.000.000 – 2.400.000
1	Very unlikely to occur	Loss value under 1.000.000

Source: Purnomo *et al.* (2021)

Data Analysis

This study harnessed the versatile HOR model to identify and mitigate risks. The HOR approach emphasizes proactive measures to decrease the likelihood of a risk factor (Parenreng *et al.*, 2019). The initial stage of this research focused on identifying beef cattle business processes, a crucial step in the risk assessment process. The results of this process description form the basis for the risk assessment withinthe HOR model. Adapted from the House of Quality (HOQ) model, the HOR model is designed to determine the priority of risk agents for preventive action (Astuti *et al.*, 2018; Parenreng *et al.*, 2019; Purnomo *et al.*, 2021). This study utilized two phases of the HOR model: HOR I was used to identify risk events and agents in the cow-herd integration system, while HOR II determined effective risk mitigation strategies based on the relationship between risk mitigation and agents. The scales for assessing the relationship between preventive actions and risk agents in HOR I and the difficulty level used in HoR II were based on similar research (Parenreng *et al.*, 2019; Astaman *et al.*, 2022).

RESULTS AND DISCUSSION

Risk Identification

Based on the results of in-depth interviews with the leading actors from the cattle-oil palm integration regarding risk events and risk agents in the dimension of the SISKA business process, the majority of risk events identified during the SISKA implementation were associated with cattle handling and rearing activities (Table 2 and Table 3). These risks are common issues faced by many actors in the livestock business, including calf mortality, errors in determining cattle prices, feed scarcity, sick cattle, poor grazing management, conflicts of interest, and the presence of pygmy cattle (Cahyadi *et al.*, 2019; Patel *et al.*, 2022; Bremer *et al.*, 2022; Astaman *et al.*, 2022). Table 2 outlines the risk agents involved in implementingSISKA. Risk agents are the causes of risk events, and a single risk agent can lead to multiple risk events (Astaman *et al.*, 2022).

In the cattle-oil palm integration system, cattle are raised using an extensive system, meaning cattle are grazed directly on oil palm plantations. The extensive system can cause risk agents to emerge, including inbreeding due to the absence of stud cattle rotation in the herd (Soedjana, 2023), weak biosecurity, and difficulty monitoring cattle when grazing (Temple & Manteca, 2020), which led to the cattle entering replanting land and community agricultural land. One of the causes of the emergence of risk agents is the absence of partnerships between farmers and oil palm companies, leading to cattle shooting and limited forage (Bremer *et al.*, 2022).

Table 2. Risk events in the SISKA

Business Process	Risk Event	Code
Cattle Care and Handling	Pygmy cattle	E1
	Limited forage	E2
	Cattle procurement	E3
	Calf death	E4
	Cattle disease	E5
	Customary law fines for farmers	E6
Marketing	Consumers use estimated prices when purchasing	E7

Table 3. Risk agent in the SISKA

Risk Agent	Code
Inbreeding	A1
Weed control by the company used herbicides	A2
Cows eating oil palm plants in replanting land	A3
The application of biosecurity is still low	A4
The mother cow does not want to breastfeed her calf	A5
Cattle enter community farmland	A6
No cattle weighing tool	A7

Risk Measurement

Tables 4 and 5 illustrate the impact of risk events along with the frequency of occurrence of risk agents on the implementation of SISKA. The displayed value represents the average response from 30 participants. The risk events that have the most significant impact on SISKA actors was the death of calves and shootings by palm oil companies. These risks threaten not only lives but also the financial security of farming households. In cattle business risk research, these two risks are also found to have the most significant impact on theft (Cahyadi *et al.*, 2019; Temple & Manteca, 2020; Astaman *et al.*, 2022). Significant calf and cattle mortality rates can disrupt the financial security of farming households, worsening poverty and inequality in rural communities dependent on livestock farming (Temple & Manteca, 2020; Avcioğlu *et al.*, 2024).

Table 4. Impact of risk event

Risk Event	Severity
Pygmy cattle	4
Limited forage	3
Shoot cows by palm oil companies	5
Calf death	5
Cattle disease	2
Customary law fines for farmers	3
Consumers use estimated prices when purchasing	2

Risk agents that often arise are not having a weighing tool in sales activities, the application of biosecurity is still low, and weed control by the company uses herbicides (Table 5). SISKA implementers are small farmers with an extensive rearing system (SCRD, 2024b); therefore, SISKA actors have limitations in business management, including limited technology, limited capital, and partnership relationships that are not legally formalized (Bremer *et al.*, 2022). SISKA actors do not yet have a legal agreement with oil palm companies, so the company is free to control weeds using herbicides.

Table 5. Frequency of occurrence of the risk agent

Risk Agent	Occurrence
Inbreeding	3
Weed control by the company used herbicides	4
Cows eating oil palm plants in replanting land	3
The application of biosecurity is still low	4
The mother cow does not want to breastfeed her calf	2
Cattle enter community farmland	2
No cattle weighing tool	5

Risk Mapping

Risk mapping in the cattle-oil palm integration business uses the house of risk matrix model. Risk priority measurement is determined by the relationship between risk sources and events, as shown by the correlation value (Parenreng *et al.*, 2019; Purnomo *et al.*, 2021; Astaman *et al.*, 2022). The HOR 1 calculation provides an overview of potential risks that will be carried out specifically to overcome these risks, which are shown by the aggregate of possible risks, the most critical risk agents, and Pareto diagrams (Astaman, 2021) (Table 6 and Figure 2).

Pareto analysis shows that challenges in livestock management are dominated by three critical issues, which together represent the largest share of existing problems. The main issue is livestock eating oil palm plants in replanting areas, indicating a serious conflict between plantation management and livestock grazing, which has the potential to cause significant economic losses for farmers and the risk of conflict between plantation companies and farmers. This issue is followed by companies' reliance on herbicides for weed control, which raises serious concerns about the risk of residues in livestock. The third major issue is maternal rejection, where cows refuse to nurse their calves, which is a serious animal welfare issue that directly affects calf mortality, growth rates, and overall herd productivity. Beyond these primary concerns, the diagram highlights several other significant challenges, though less frequent, that collectively impact livestock health, productivity, and community relations, including inadequate biosecurity, inbreeding, absence of weighing equipment, and livestock encroachment on community farmland. To achieve optimal efficiency, it is crucial to focus improvement efforts on resolving the the three main root causes first, as addressing these will significantly reduce the overall problem. Three risk agents were found to have the most considerable aggregate risk potential value out of seven: cows entering the replating land, weed control by the company using herbicides, and inbreeding. Therefore, these three risk agents will be selected as priorities for risk mitigation (Astuti *et al.*, 2018; Astaman *et al.*, 2022).

Table 6. Result HOR I Analysis

Risk Event	Risk Agent							Severity
	A1	A2	A3	A4	A5	A6	A7	
E1	9				3			4
E2		6						3
E3			9					5
E4				3	6			5
E5	3	3		6				2
E6						9		3
E7							9	2
Occurrence	2	4	3	4	3	2	5	Total ARP
Aggregate Risk Potential (ARP)	66	120	135	96	99	36	45	630
Rank	5	2	1	4	3	7	6	

Note: E1 = Pygmy cattle; E2 = Limited forage; E3 = Cattle procurement; E4 = Calf death; E5 = Cattle disease; E6 = Customary law fines for farmers; E7 = Consumers use estimated prices when purchasing; A1 = Inbreeding; A2 = Weed control by the company used herbicides; A3 = Cows eating oil palm plants in replanting land; A4 = The application of biosecurity is still low; A5 = The mother cow does not want to breastfeed her calf; A6 = Cattle enter community farmland; A7 = No cattle weighing tool.

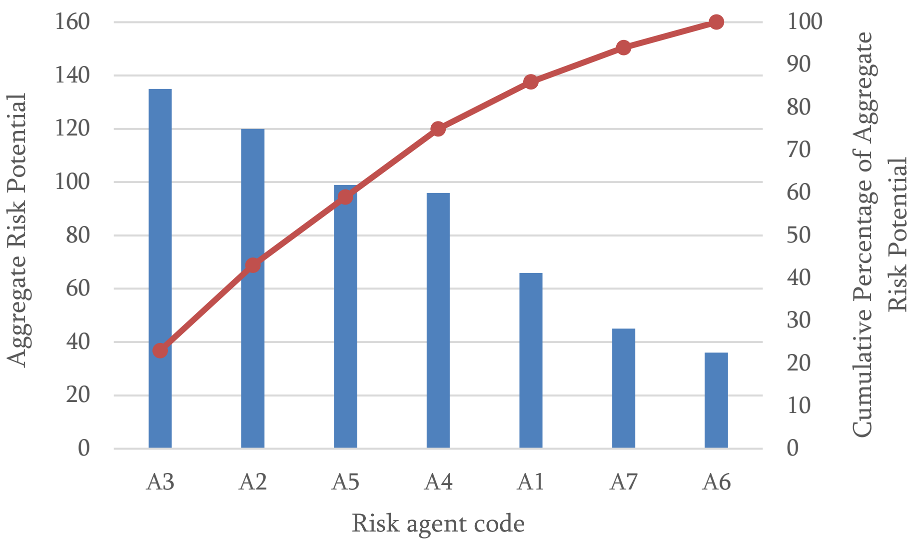

Figure 2. Pareto Diagram of Potential Risk Aggregate of the Risk Agents. Note: A1 = Inbreeding; A2 = Weed control by the company used herbicides; A3 = Cows eating oil palm plants in replanting land; A4 = The application of biosecurity is still low; A5 = The mother cow does not want to breastfeed her calf; A6 = Cattle enter community farmland; A7 = No cattle weighing tool.

Risk Mitigation

Once all HOR Phase 1 process stages are completed, the next step is to analyze HOR Phase 2. The HOR model serves as the foundation for risk management, emphasizing prevention and reducing the likelihood of risk factors (Parenreng *et al.*, 2019; Purnomo *et al.*, 2021; Astaman *et al.*, 2022). Based on the results of in-depth interviews with respondents, several strategic plans have been formulated, as shown in Table 7.

Various strategies can be used to improve the implementation of cattle-palm oil integration systems and reduce potential risks. There are three mitigation strategies for risk agents of cattle entering replanted land. The first strategy is to use electric fencing. This method not only restricts cattle within certain boundaries of the oil palm plantation but also contributes to maintaining animal health by protecting them from predators and diseases (Santoso *et al.*, 2022). The second strategy is the implementation of semi-intensive rearing patterns. Applying semi-intensive rearing patterns can facilitate the control of cattle (Ilham *et al.*, 2021). The third strategy is a rotational grazing system. A rotational grazing system can reduce damage to oil palms by cattle (Darsono, 2023b). The legalization of cooperation with the company can mitigate the risk of weed control by the company using herbicides. Partnerships between companies and cattle farmers through joint grazing and joint forage procurement can increase the success of SISKA implementation (Santoso *et al.*, 2022; Bremer *et al.*, 2022). The limited number of superior males causes the incidence of inbreeding in SISKA implementation, so the strategy to mitigate it is to buy or rotate superior males (Santoso *et al.*, 2022; Soedjana, 2023).

At the HOR 2 stage, the total effectiveness of each mitigation action is determined by assessing the difficulty of implementing risk mitigation (Dk). This Dk value plays a key role in calculating the effectiveness ratio to the difficulty of action k (ETDk) (Table 8).

Table 7. Mitigation Actions for risk minimization

Risk Agen	**Mitigation Action**	**Code**
Cows entering the replating land	Use electric fencing	M1
	Semi-intensive cattle rearing	M2
	Rotational grazing system	M3
Weed control by the company using herbicides	Legalization of cooperation with the company	M4
Inbreeding	Procurement of superior male cattle	M5
	Superior male cattle rotation	M6

Table 8. Results of a comprehensive HOR II analysis

Risk Agen	**Mitigation Action**						**Aggregate Risk Potential**
	M1	**M2**	**M3**	**M4**	**M5**	**M6**	
A3	9	3	6				135
A2				9			120
A5					9	9	99
Total Effectiveness of Proactive Action k (TEk)	1215	405	810	1080	891	891	
Action k (Dk)	3	3	3	5	4	3	
Effectiveness to Difficulty Ratio of Action k (ETDk)	405	135	270	216	222,75	297	
Rank of Proactive Action k	1	6	3	5	4	2	

Note: A2 = Weed control by the company used herbicides; A3 = Cows eating oil palm plants in replanting land; A5 = The mother cow does not want to breastfeed her calf; M1 = Use electric fencing; M2 = Semi-intensive cattle rearing; M3 = Rotational grazing system; M4 = Legalization of cooperation with the company; M5 = Procurement of superior male cattle; M6 = Superior male cattle rotation

Three priority strategies can be implemented to mitigate risk agents in the implementation of SISKA:the use of electric fencing, the implementation of a rotational grazing system, and the procurement of superior male cattle. Of the three priority strategies, the strategy with the first rank is the use of electric fencing. This indicates that the use of electric fencing is a strategy that is easy to implement to reduce the risks that have a major impact on the implementation of SISKA Parenreng *et al.*, 2019; Purnomo *et al.*, 2021; Astaman *et al.*, 2022; Santoso *et al.*, 2022).

CONCLUSION

Risk factors that must be prioritized for management include cattle entering replanting areas, herbicide use by companies for weed control, and inbreeding. Farmers in the SISKA Cluster can implement three handling strategies effectively and efficiently: using electric fencing, implementing a rotational grazing system, and procuring superior male cattle. Actions that the West Kalimantan Province Government can take to ensure the sustainability of SISKA implementation are the procurement of electric fences and superior stud cattle, as well as initiating cooperation between oil palm plantation companies and SISKA business actors. This research is limited to the risk of implementing SISKA from the farmers' perspective. Therefore, to complement this research, it is necessary to assess the risk of implementing SISKA from the perspective of Palm Oil Plantation Companies.

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