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Scenario for Sustainable Food Plantation Forest Management in the Former Peatland Development Area of Central Kalimantan, Indonesia

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ABSTRACT

The challenge of food production for a growing population is a global issue prioritized in the UN Sustainable Development Goals (SDG-12), especially for developing countries such as Indonesia. Various policies have been issued by the Government of Indonesia, including policies to strengthen food security with a food estate approach on peatlands. Several previous studies have shown the failure of food estate from economic, ecological, and socio-cultural aspects. However, in 2020, food estate was again implemented with the same policy, which generated controversy. In contrast to previous studies, this research focuses on peatland development for food security that can accommodate conservation and economic interests while providing social benefits fairly and sustainably in the former peatland development area of Central Kalimantan through a process of analyzing the content of land provision policies, multidimensional sustainability, financial feasibility, and normative and exploratory scenario analysis. The research findings have shown that implementing the food estate policy has led to agrarian conflicts (horizontal and vertical). Furthermore, the results of the analysis of the four scenarios that have been developed show that scenario IV (agroforestry based on eucalyptus oil, rubber, MPTs, and food crops) is the most feasible scenario to implement with NPV IDR 1,618,787,988; BCR 1.77; and IRR 32.92%. Thus, the improvement of key indicators in each aspect, viz: decreased intensity of land fires (ecological), absorption of local labor (economic), and decreased intensity of land conflicts (social) are important steps in achieving inclusive and sustainable food security on peatlands.

Introduction

Food production challenge for a growing population is a global issue prominently featured in the UN's Sustainable Development Goals (SDG-12), with responsible consumption and production. According to FAO [1], 7.8 billion people live on Earth, with 815 million estimated to be malnourished. The global food system does not provide sufficient, safe, and nutritious food because it does not produce the diversity of foods required for a healthy diet [2].

Sustainability in food production systems is greatly influenced by globalization and world population growth, transportation, processing, and consumption, and greatly increasing global food waste [3]. Thus, a sustainable food system is crucial for limiting global carbon emissions [4]. The need to reduce food loss and identify key sources to meet food security challenges through effective and sustainable food supply chain processes would be substantially improved in terms of nutritional diversity and cost-effectiveness [5].

The Indonesian government also issued a policy to strengthen national food security through the "food estate" program as one of the 2020–2024 National Strategic Programs (PSN), which was built to strengthen national food reserves from upstream to downstream in several provinces in Indonesia, including Central Kalimantan, Sumatra, and Papua. The food estate was run with the involvement of several ministries which is, the Ministry of Agriculture provides agricultural production facilities and supervises agricultural cultivation

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[6], whereas the Ministry of Defense is responsible for developing cassava food reserves [7]. The Ministry of Forestry and Environment (KLHK) contributes to the provision of Forest Areas for Food Estate Development or Forest Areas for Food Security (KHKP) through Minister of Environment and Forestry Regulation No. P.24/MENLHK/SETJEN/KUM.1/10/2020, as well as through programs specifically developed to support food production from the forestry sector [8].

Food security policies using a food estate approach have been implemented several times in the previous government era and continue to fail, namely, the Bulungan food estate, East Kalimantan, in 2011 and the Merauke Integrated Food and Energy Estate (MIFEE), Papua in 2011, causing problems including 1) providing land and overlapping land; 2) water scarcity during the dry season and flooding during the rainy season due to irrigation networks that are not under the management of the biophysical conditions of peat; 3) formal and customary land release conflicts due to the land being cleared as sacred customary land; and 4) social inequality conflicts between local communities and transmigrants, and other problems that have become very complex [9].

The results of the Former Peatland Development (Ex-PLG) handling team showed that the PLG planning stage violated the standard procedures in swamp development activities. Environmental Impact Analysis (AMDAL) was conducted after the PLG program had been running for almost a year, having a negative impact on the physical, biological, and social environment, and natural resource planning was carried out with many assumptions without clear data. The lack of understanding of local socio-cultural conditions due to the absence of involvement of local communities in planning proves weak compliance with the principles of social justice and sustainability.

The long journey of food estate failure has provided an important note on forest and land management for food security and shows the complexity of the problems in making it happen. Treats and challenges that must be considered in food estate projects include forest fires, climate change, socio-economic issues, and other issues that may occur [10]**.** The main factors causing the failure of food estates in Indonesia are the lack of mature development concept planning (development location plans, water availability, climate conditions, technology, and synergy between the government and farmers), land ownership issues that give rise to conflicts between the community and the government, the ability of farmers' resources to manage agricultural land effectively, and policies prepared by the government that are still not being implemented to maximize production results and agricultural quality [11].

Several studies have examined land development for sustainable food security using the food estate approach. From this perspective, researchers have reported that realizing sustainable food estate development requires the development of endemic peatland commodities [12], environmental feasibility [13], legal bases (social norms and land security) [14], protection of community rights [15], food diversification and economic feasibility [16]. However, there has been no research that increases local community participation to achieve ecological justice through inclusive land management policies (both for nature and humans) by integrating diverse local commodities that are worth developing ecologically (adaptive to biophysical peat), economically (increasing local employment), and socio-culturally (does not cause conflict). It is hoped that the results of this research can be used as a consideration for stakeholders (government, NGOs, and the private sector) in developing conservation strategies and improving community welfare to achieve food security goals with a sustainable food estate approach.

Materials and Methods

Study Area

The research was conducted in the Former Peatland Development (Ex-PLG) Block C, Pulang Pisau Regency, Central Kalimantan, and research activities were carried out in the 2022–2023 period. The PLG area is one of the priority areas for extending food estates in Central Kalimantan. The PLG area is divided into two districts, Pulang Pisau Regency and Kapuas Regency, with a total area of 770,601 ha.

Data Collecting

The secondary data required in this study were collected through a literature review. Primary data were obtained through surveys, in-depth interviews, and questionnaires distributed to food storage farmer groups and local communities in the ex-PLG area. Materials used in data processing, such as economic, sociocultural, and policy data, as well as literature reviews, are used to support and strengthen conclusions.

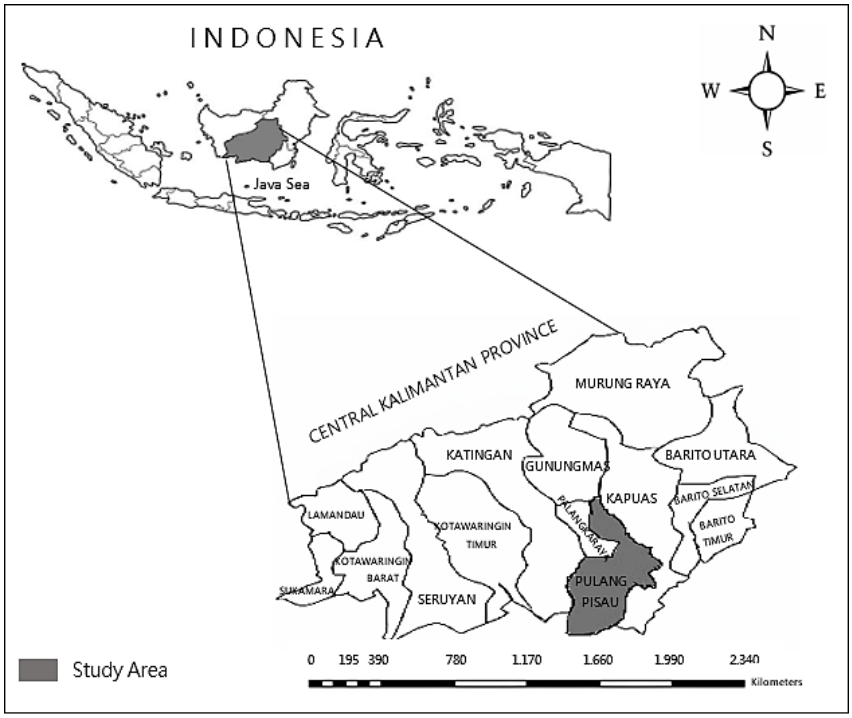

Figure 1. Study area.

Data Analysis

Policy Analysis

Data originating from statutory regulations and written documents were qualitatively analyzed using content analysis techniques [17]. Field data explain the potential for agrarian conflict caused by the design of the food estate land extensification policy by comparing the results of the content analysis of regulations with their implementation in the field. This method was proposed by Birner as ex-post or retrospection analysis as an evaluative model by evaluating the impact or implementation of a policy [18]. The policies analyzed are 1) provisions or guidelines stipulated in land procurement for prospective farmers' land (CPCL), 2) maximum land area, 3) land procurement mechanisms, 4) security of ownership, and 5) rights and obligations that can be obtained must be fulfilled by community/farmer groups in the program being implemented.

Business Feasibility Analysis

The business feasibility analysis in this study uses the criteria and indicators contained in the Market Analysis and Development (MAD) method which is used to analyze the feasibility of business utilization of forest and peatland products by the community [19]. The purpose of this method is to develop forestry businesses by the community efficiently while still paying attention to environmental and socio-cultural sustainability. The analysis in this method includes analysis of ecological aspects, economic aspects, and socio-cultural aspects as well as financial feasibility analysis.

The indicators of ecological aspects use indicators of local ecological wisdom, peatland conversion rate, level of land suitability, land fertility, subsidy rate, drought events, intensity of land fires, land and water management, use of ameliorants/fertilization, land productivity, and application of conservation techniques. The economic aspect uses the market access indicator, marketing targets, marketing process of production products, agricultural business prospects, source of livelihood, absorption of local labor, farmers' income from peatlands, land ownership status, level of land tenure, and income from peat swamp forests. The social aspect indicator is the role of farmers for sustainability, community knowledge about peatlands, product marketing opportunities, intensity of land conflicts, customary rules and local wisdom, participation of family members, support from village government officials, land status, and education level.

The financial feasibility analysis uses the criteria of Net Present Value (NPV) (Equation 1), Gross Benefit Cost Ratio (Net B/C Ratio) (Equation 2), and Internal Rate of Return (IRR) (Equation 3) [20]. The business feasibility criteria in this study are considered feasible if: NPV > 0, BCR > 1, IRR greater than the discount rate. In the BCR method there are three investment feasibility criteria [21].

$$\text{Net present value (NPV)} = \sum \frac{(Bt-Ct)}{(1+i)^t} \quad (1)$$

Where Bt is income (benefits) in year t, Ct is costs (expenses) of the t-th year, t is project age (years), and i is interest rate (discount rate) (%).

$$\text{Benefit and Cost Ratio (BCR)} = \sum \frac{\frac{Bt}{(1+i)^t}}{\frac{Ct}{(1+i)^t}} \quad (2)$$

Where Bt is income (benefits) in year t, Ct is costs in year t, t is project age (years), and i is interest rate (discount rate) (%).

$$\text{Internal Rate of Return (IRR)} = i^1 \frac{NPV\ 1}{NPV1-NPV2} (i2\text{-}i2) \quad (3)$$

Where NPV1 is NPV with a positive value, NPV2 is NPV with a negative value, i1 is interest rate that makes the NPV value positive, and i2 is interest rate that makes the NPV value negative.

In the IRR method, if IRR ≥ the interest rate, then the business is accepted or feasible; if IRR < interest rate, then the business is rejected or not feasible. The assumptions built for financial analysis in this study are: 1) Financial analysis is carried out on a land area of 100 ha. For Timber Forest Products (galam), the annual block is 10 ha year^{-1}, and the eucalyptus oil leaf harvest rotation is 6–7 months with an area of 10 ha in one harvest. Meanwhile, rubber plants, multipurpose tree species (MPTs), and food crops are carried out on an area of 100 ha; 2) the productive life of eucalyptus, *petai* (*Parkia speciosa*), *cempedak* (*Artocarpus integer*), and rubber oils is 25 years so that the investment period (management period) is set for 25 years; 3) the interest rate (discount factor) used comes from the microcredit interest rate of Bank BRI, which is 6%; 4) the unit of financial analysis used is IDR ha^{-1} year^{-2}; 5) the cost components of land clearing, seed procurement, planting, maintenance, and harvesting are suspected to be the daily worker wages applicable at the research site; 6) the management capital of timber forest products (HHK) galam used is capital from members of the *Peramu* galam farmer group and the government (Bank Kalteng); 7) the management capital of eucalyptus oil, rubber, MPTs crops, and food crops used is all capital of members of village forest management institutions (LPHD), members of community forest management institutions (HKm) and the government (Bank Kalteng); 8) the price of galam (*Melaleuca leaucadendron*) wood in the first year of harvest is IDR 7,500 per shoot, eucalyptus oil yield is IDR 350 per mL^{-1}, rubber is IDR 6,000 kg^{-1}, *petai* fruit is IDR 10,000 per stalk, *cempedak* is IDR 15,000 kg^{-1}, chilli *(Capsicum annuum)* is IDR 30,000 kg^{-1}, and sweet potatoes (*Ipomoea batatas*) is IDR 10,000 kg^{-1}. All prices are assumed to be constant.

Sustainability Analysis

Multidimensional Scaling (MDS) is the method used to analyze sustainability in this research, which has been modified from the Rapfish (Rapid Appraisal for Fisheries) and was named the Rap-Peat Model. Rapfish software is a development of MDS found in SPSS for the rotation process, reverse position, and several sensitivities analyses combined into one software. The Rapfish model is carried out by grouping the main attributes developed into three dimensions (ecological, economic, and social). This stage looks for opportunities, alternatives, and solutions for improvement based on sensitive attribute values. The position of the sustainability point is visualized through the MDS process in two horizontal and vertical axes. To project these points on a horizontal line, a rotation process is carried out with bad extreme points with a score value of 0% and good extreme points with a score value of 100%, as well as index categories and sustainability status at scores of 00.00–20.00 (not sustainable), 20.01–50.00 (less sustainable), 50.01–75.00 (quite sustainable), and 75.01–100 .00 (very sustainable) [22].

Determination of the Best Scenario

There are two scenario planning models [23]. First, normative scenario planning aims to achieve certain targets; second, exploration scenario planning aims to explore uncertainty [24]. Both are approaches used in determining sustainable food plantation management scenarios on peatlands. The direction has been set deliberately, from determining the desired results (preventing increased conversion and degradation of peatlands) to creating a list of all stakeholders. In developing this approach, the determinants of multidimensional leverage analysis (ecological, economic, and social) are key at this stage.

Results

Content Analysis of Food Estate Land Extensification Policy

Food estates in Central Kalimantan are run using a system of land intensification (increasing the productivity of existing rice fields) and land extensification (increasing productivity through expanding agricultural land). Implementation of design investigation survey (SID) activities for prospective CPCL and rice field extensification designs are carried out in a self-managed manner with other government agencies (IPL) guided by Presidential Regulation No. 16 of 2018 concerning Government Procurement of Goods/Services and its amendments, and regulations, namely Presidential Regulation No. 12 of 2021 and Government Goods/Services Procurement Policy Institute (LKPP) Regulation No. 08 of 2018, concerning Self-Management Guidelines with a self-management structure. Based on the contents of the implementation guidelines (Juklak) for the investigation & design survey (SID) for food estate extensification in Central Kalimantan Province in 2021, 11 narratives were found that regulate the general provisions for determining food estate areas, which were then seen in their implementation in the field, shown in table 1.

Table 1. Narrative of regulations/instructions for implementing food estate extensification.

Narrative of regulations/implementation instructions	Application
This location is not included in forest areas, moratorium areas on peat land use, peat domes, areas for determining indicative maps for delays in granting new permits (Pippi) utilization of forests, and areas that are already burdened with other rights and permits.	In accordance with
The type of land ownership status is clear (owned land, customary land, or state land) and there are no obstacles to development due to land ownership status.	Inappropriate
Land ownership boundaries are clear (no disputes).	Inappropriate
Land use does not overlap with other programs and projects.	In accordance with
It is economically feasible and there are no social problems that have the potential to hinder the implementation of rice field extensification activities and the use of new rice fields.	In accordance with
Located in the area of interest (AOI) for the development of the food estate area in Central Kalimantan, in this case there are 2 (two) areas of interest (AOI) (Ministry of Public Works and Coordinating Ministry for Economic Affairs).	In accordance with
If the land type is peat, the maximum peat thickness is 1 meter and the pyrite depth is a minimum of 60 cm.	In accordance with
The prospective location is included in an agricultural cultivation area or agricultural cultivation development area.	In accordance with
Farmers are present and domiciled in the prospective location village or close to the prospective location and are committed to working on the rice fields.	Inappropriate
If at the candidate location there is land whose owner is not domiciled in the village where the candidate is located, then follow the following: Willing to take part in the rice field extensification program and appoint cultivators to work on the rice fields whose land will be expanded and must be stated in writing in a letter of agreement between the land owner and the cultivator. If the owner cannot be contacted/is unwilling to participate in the program and the land cannot be included in the program.	 Inappropriate Inappropriate
Conformity percentage	55%

The gap between the content of the policy and its implementation reaches 45%. The results of primary data processing obtained from the results of the interviews showed that only 6 out of a total of 11 narratives were carried out in accordance with the Juklak guidelines for the procurement of prospective CPCL candidates in the food estate program in Simpur Village and Pilang Village, Puklang Pisau Regency, Central Kalimantan.

Financial Feasibility Analysis

This analysis aims to find financially viable land management alternatives to support the welfare of farmers, especially communities that are part of the peatland agroecosystem. Based on the results of surveys and interviews with local communities in the ex-PLG area, seven types of plants were found that have quite a large potential for development. The NPV calculation results obtained from managing the seven types of plants have an NPV >0. The BCR value obtained from the calculation results for the seven types of plants all meet the business feasibility criteria, namely BCR>1. Meanwhile, the IRR value for seven plant types is greater than the discounted rate (6%). Financially, eucalyptus oil has a higher NPV value than other crops, namely, IDR 305,660,377. The overall results of the analysis in these studies show that the eucalyptus oil refining business is profitable and feasible to run.

Table 2. Financial feasibility analysis.

Plant type	NPV	BCR	AND
Galam (*M. leucadendron*)	IDR 30,260,870	1.63	48.59%
Eucalyptus oil	IDR 42,452,830	1.58	22.54%
Petai (*P. speciosa*)	IDR 11,320,755	1.36	38.06%
Cempedak (A. integer)	IDR 13,915,094	1.65	30.13%
Rubber *(Hevea brasiliensis)*	IDR 19,339,623	1.29	13.63%
Sweet potatoes *(I. batatas)*	IDR 18,943,396	1.81	25.98%
Chilli *(C. annuum)*	IDR 16,188,679	1.62	15.68%

Ecological Dimension Sustainability Analysis

The results of the ordination analysis using Rap-Gambut on seven types of plants managed by the community on peatlands have a sufficient sustainability index for each type of plant (Table 3). Therefore, in general, the sustainability of food plantation forest management from ecological aspects in the ex-PLG area of Central Kalimantan is included in the moderately sustainable category (62.90%). Leverage analysis was carried out to see the sensitive attributes that contribute to the value of the ecological dimension sustainability index. Based on this analysis, four attributes fall into the sensitive category, namely a) intensity of land fires, b) use of ameliorant materials/fertilizers, c) rate of subsidence, and d) land and water management. The results of the leverage analysis are shown in Figure 1.

Table 3. Ecological dimension index values.

Plant type	Ecological dimension sustainability score			
	Multidimensional	Monte Carlo	Difference (%)	Sequence
Galam (*M. leucadendron*)	72.42	71.54	72.42	1
Eucalyptus oil	64.21	63.53	0.68	3
Petai (*P. speciosa*)	63.68	63.36	0.32	4
Cempedak (A. integer)	68.00	67.81	0.19	2
Rubber *(H. brasiliensis)*	52.18	51.67	0.51	7
Sweet potatoes *(I. batatas)*	60.93	60.71	0.22	5
Chilli *(C. annuum)*	58.87	58.88	0.02	6
Average	62.90			

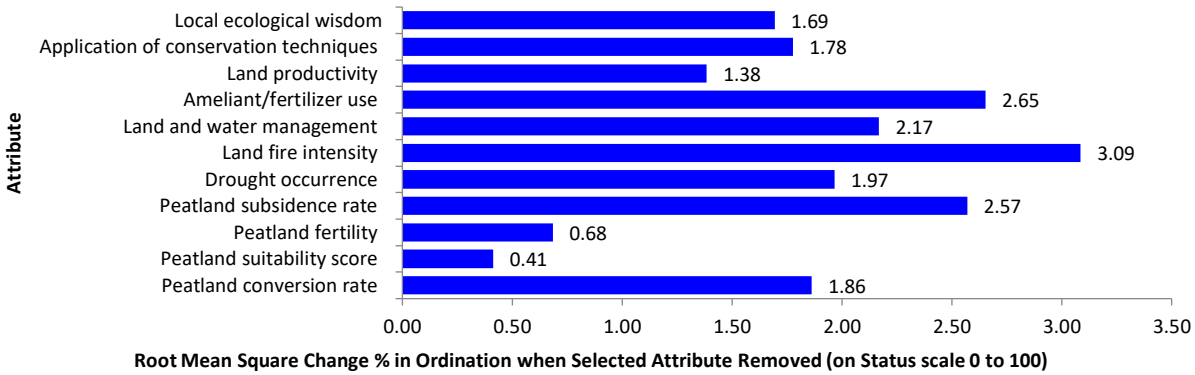

Figure 2. Sensitive attributes of ecological dimension.

Economic Dimension Sustainability Analysis

The sustainability value of the economic dimension of 60.51 in Table 4 shows that from an economic perspective, the management of food plantation forests in the ex-PLG area has a fairly sustainable status. The value of the sustainability index for the economic dimension is lower when compared to the ecological dimension, but the value is not much different. This sustainability status is due to ten supporting attributes of the observed economic dimension, five of which fall into sensitive categories, including labor absorption, land ownership status, livelihood sources, agricultural business prospects, and production marketing processes, as shown in Figure 2.

Table 4. Economic dimension index values.

Plant type	Sustainability dimensions of economic score			
	Multidimensional	Monte Carlo	Difference (%)	Sequence
Galam (*M. leucadendron*)	68.34	67.77	0.56	2
Eucalyptus oil	73.57	72.64	0.92	1
Petai (*P. speciosa*)	55,75	55.16	0.59	5
Cempedak (A. integer)	57.16	56.56	0.60	4
Rubber *(H. brasiliensis)*	52.57	52.59	0.02	7
Sweet potatoes *(I. batatas)*	53.27	53.44	0.18	6
Chilli *(C. annuum)*	62.89	62.24	0.65	3
Average	60.51			

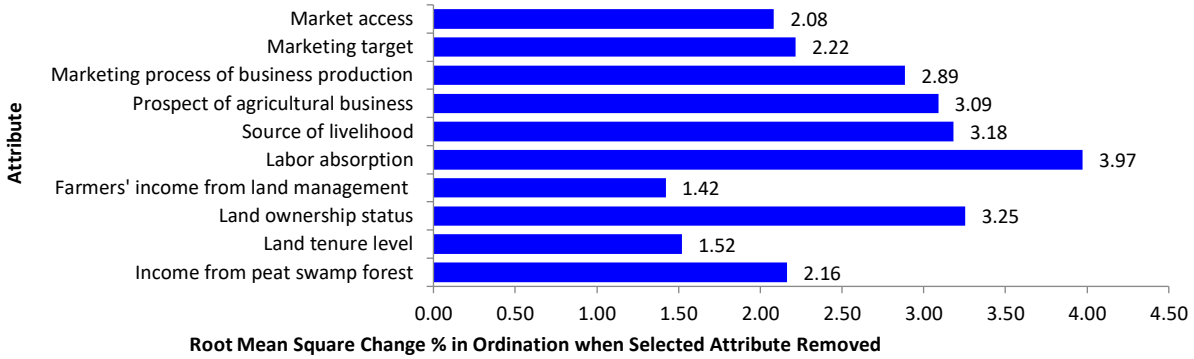

Figure 3. Sensitive attributes of economic dimensions.

In the economic dimension, a sensitive attribute that can improve the sustainability of food plantation forests is increasing labor absorption. Based on the results of interviews in the field, local communities generally have land with different areas, namely 2–5 ha. However, the land managed mainly for food crops is relatively small, so land management work is carried out by families. On the other hand, inadequate market access also causes farmers not to dare to manage too much land so their contribution to labor absorption is quite small.

Social Dimension Sustainability Status

The analysis results on the social dimension sustainability score have an average of 56.82, which shows that forest and peatland management has a fairly sustainable status (Table 5). Overall, plants managed by the community have a fairly sustainable sustainability index, but there is one type of plant with an unsustainable index, namely rubber plants, at 49.20%. Socially, rubber plants have a poor value (<50%).

Table 5. Social dimension index values.

Plant type	Social dimension sustainability score			
	Multidimensional	Monte Carlo	Difference (%)	Sequence
Galam (*M. leucadendron*)	60.03	59.53	0.50	2
Eucalyptus oil	53.68	53.44	0.25	6
Petai (*P. speciosa*)	58.78	58.82	0.04	4
Cempedak (A. integer)	54.54	54.38	0.16	5
Rubber *(H. brasiliensis)*	49.20	49.15	0.05	7
Sweet potatoes *(I. batatas)*	58.79	57.87	0.92	3
Chilli *(C. annuum)*	62.70	61.98	0.73	1
Average	56.82			

Based on the results of interviews with rubber tappers, the factors that cause the rubber to no longer be a leading commodity are: a) price factors that are always falling and unstable; b) the quality factor of the rubber produced is not able to compete with synthetic rubber; c) public knowledge in producing rubber with high selling value; and d) inadequate market access. Unlike rubber plants, chilli plants have a higher sustainability index value than other types of plants. This is due to the high level of demand from mid-2022 to early 2023, when the price of chilli reached IDR 60,000 kg^{-1}, even though there was a decrease in the price of chilli to IDR 25,000 kg^{-1} in mid-2023, according to farmers this will not have much impact on chilli farmers, because in addition to being sold, chilli peppers are also grown for personal consumption so that chilli plants are superior

to other crops from social aspects. However, improvements must be made to several attributes sensitive to index values. The results of this analysis can be seen in Figure 3. Based on the results of the leverage analysis, the most sensitive aspects that need to be prioritized are the intensity of land conflicts, customary rules, and local wisdom, as well as product marketing opportunities.

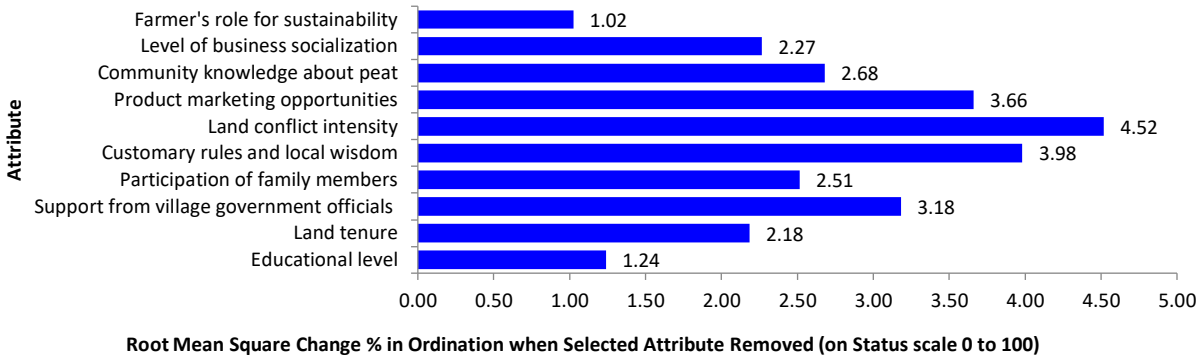

Figure 4. Sensitive attributes of social dimensions.

Multidimensional Analysis of Sustainability

The sustainability status of multidimensional food crop management is at a fairly sustainable sustainability index, which is 58.57%. This status is obtained from each index value in each dimension shown in Table 6. The analysis of forest and peatland management in three dimensions, namely the ecological, economic, and social dimensions, shows that the ecological dimension has the highest sustainability index, followed by the social dimension, and the lowest is the economic dimension. It shows that none of the dimensions are classified as bad. The multidimensional sustainability index is presented in Figure 4. Overall, of the seven types of plants, the galam tree has a higher ecological dimension than other plants, while in the economic dimension eucalyptus oil is superior to other plants, and in the social dimension the chilli plant has an advantage compared to other plants.

Table 6. Multidimensional index values.

Dimensions	Index	Status
Ecology	68.52	Quite sustainable
Economy	55.06	Quite sustainable
Social	58.52	Quite sustainable
Multidimensional	58.57	Quite sustainable

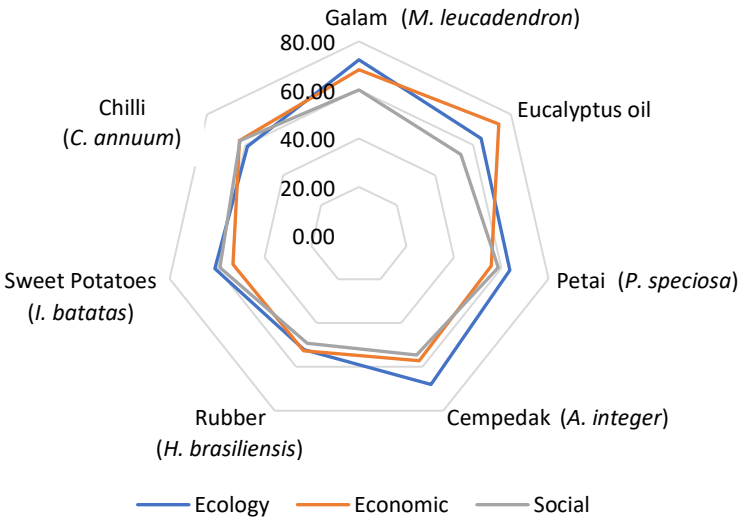

Figure 5. Multidimensional kite diagram.

Index Sensitivity Test and Sustainability Status

The statistical test at this stage aims to illustrate the validity of the MDS analysis by comparing the S-Stress value (a measure of the discrepancy between data and MDS measurements) to the Root Mean Square (RMS) value of each dimension. Overall, the stress value for multi-dimensional, ecological, economic, and social dimensions is less than 0.25 or 25%. Meanwhile, the coefficient of determination (R2) for each dimension is close to 1 or 100%, indicating that the accuracy of the analysis results can be accounted for. The following voltage and R2 values are shown in Table 7.

Table 7. Sensitivity analysis.

Statistical parameters	Dimensions			
	Ecology	Economy	Social	Multidimensional
Emphasize dimensions	0.14	0.14	0.14	0.14
R2	0.95	0.95	0.95	0.92

The final stage in analyzing sustainability is to carry out a Monte Carlo analysis; this analysis is used to assess the magnitude of error factors or mistakes in the analysis; these factors come from differences in the attribute assessments of each respondent, errors in entering data, and incompleteness. Table 8 reveals that the discrepancy between the outcomes of the MDS analysis and Monte Carlo analysis is strikingly minor, measuring less than 5%.

Table 8. Monte Carlo analysis.

Dimensions	Miltidimensional	Monte Carlo	Difference
Ecological	61.74	61.02	0.72
Economical	55.06	55.89	0.16
Social	58.52	57.89	0.63
Multidimensional	58.57	57.93	0.64

Scenario Preparation

The development of food plantation forest management scenarios consists of four scenarios. Scenario development aims to simulate business development and determine the best management scenario based on ecological, financial, and social analysis. The factors in developing this scenario are stand potential, production volume, interest rates, and management period. The study period is limited to 25 years, from 2022 to 2047 with an interest rate of 6% (Bank BRI in 2022), and the price of each commodity is assumed to be constant every year.

Scenario I: Management of Eucalyptus Oil and Galam (M. leucadendron) Trees

Scenario I is assumed to only run a business on wood forest products and non-timber forest products as the main income. In this scenario, the two types of planting are carried out on different land, but in the same stretch. A fifteen-year time management simulation.

Scenario II: Management of Eucalyptus Oil, Rubber, and MPTs Businesses

Scenario II is assumed to carry out land management efforts with a combination of 3 types of non-timber forest products, rubber plants, and MPTs plant types. Simulation of management time for fifteen years, assuming eucalyptus oil and rubber as the main income. Even though the sustainability status of rubber is socially unsustainable, rubber plants are still included in this scenario because the rubber latex business is a business passed down from generation to generation in the study area and is still in demand, so for the development of scenarios (II, III, and IV) it is necessary to formulate an empowerment strategy for the Rubber farmers/planters to increase farmer capacity and market access.

Scenario III: Management of Eucalyptus Oil, Rubber, and Food Crop Businesses

Scenario III assumes land management with a combination of eucalyptus oil, rubber and food crops with a simulated management time of fifteen years. In this scenario, eucalyptus oil is assumed to be the main income.

Scenario IV: Management of Eucalyptus Oil, Rubber, MPTs, and Food Crops Businesses

Scenario IV is assumed to carry out land management efforts using an agroforestry system with a simulation of fifteen-year management time. Scenario IV uses a combined land management system between eucalyptus oil crops, rubber plants, MPTs, and food crops, except for trees (Timber Forest Products) and

galam. The galam tree does not fall into this scenario because the galam tree is too dominant. Although the galam tree is very adaptive to acidic soil conditions, other plants will not be able to compete because the galam tree is so dominant that it cannot be combined with other plants. However, efforts to manage galam trees will be carried out using land different from other plants.

Scenario Financial Analysis

Based on multidimensional sustainability analysis, all scenarios are feasible, so the final assessment depends on financial feasibility. Stand potential, production volume, interest rates, and management period need to be considered in preparing this scenario. The constraints used in developing this scenario include the period used in this research, which is 25 years from 2022 to 2047, the interest rate used, which is 6% (Bank BRI in 2022), and the price of each commodity (assumed to be constant every year).

Table 9. NPV values in each scenario.

Scenario	NPV	BCR	IRR	Rating
Eucalyptus oil, galam	IDR 259,481,352	1,94	57,96%	4
Eucalyptus oil, rubber, MPTs	IDR 1,145,295,226	2,68	66,13%	2
Eucalyptus oil, rubber, food plants	IDR 1,119,065,873	1,60	30,86%	3
Eucalyptus oil, rubber, MPTs, food plants	IDR 1,618,787,988	1,77	32,92%	1

In general, all scenarios have a positive NPV value, so they are worth doing. The scenario with the highest NPV value is the best scenario which is more profitable and more worthy of being chosen. Based on the scenarios created, the best scenario is scenario IV which is seen with an NPV value of IDR 1,618,787,988 with a BCR value > 1 and an IRR value > (6%).

Discussion

Content Analysis of Food Estate Land Extensification Policy

Food estate is one of the National Strategic Programs (PSN) in Indonesia that has an important role in the democratic process. This program aims to increase economic growth, expand equitable development, and improve community welfare. However, such ambitious goals must be accompanied by careful planning and supervision; Without it, it can actually give rise to new problems. An analysis of food estate policies and their implementation in the field reveals three main findings.

First, there is an injustice in the distribution of the Design Investigation Survey (SID) process which is carried out in a limited and non-participatory manner. This makes information not spread evenly and on target, while the information received by the public becomes confusing, potentially triggering conflicts. Distributive justice is an important concept related to the equitable distribution of resources, rights, and obligations among members of society. In the context of CPCL food estate, it demands that all members of a farmer group, regardless of ethnic, religious, or socioeconomic status, have equal access to resources and information, including in the SID process. In some cases, there are people who are not even aware that their land is involved in the food estate program. The SID team often relies only on statements from local guides appointed by village heads, without direct verification from land owners. This kind of process can create conflicts between landowners and local guides, create clear distribution inequities and violate the rights of landowners. As a result, conflicts arise between the community, the head of the farmer group, and the village government. Indigenous peoples and farmers are often the main victims in these agrarian conflicts, as they generally have limited access to political and economic power to defend their rights to [25]. Therefore, principles such as distributive justice, community participation, and environmental sustainability are important foundations in designing a just and inclusive development paradigm. This approach is not just an alternative, but a must to face increasingly complex and urgent global challenges [26].

Second, the role of Field Agricultural Extension Workers (PPL) as an institution responsible for providing direction, guidance, and counseling in the agricultural sector at the site level is still not optimal, especially related to implementing the rice food estate policy on swampland. The rice field printing land management system is a new agricultural approach for the Simpur Village and Pilang Village communities. Previously, residents in these two villages had a tradition of farming fields (mountain rice) going on for generations. The presence of the food estate program encourages people to learn new skills. However, problems arise when existing resources are inadequate, and there is a lack of intensive assistance from related institutions. This disrupts the cultural shift in the local food fulfillment system, thus creating new problems in the community.

Cultural systems teach us about caring for people: how they see, feel, and understand the world around them and act according to the values they embrace [27]. Suppose the food estate program is not adapted to the local socio-cultural conditions and there is no in-depth assistance for the local community. In that case, the risk of crop failure and increased poverty levels will become more apparent.

Third, there are serious problems related to the absence of a control mechanism in the implementation of food estate policies. The absence of provisions regarding the division of village land in the process of identifying CPCL for food estates has been taken advantage of by a number of local elites. They unevenly distribute land and prioritize certain groups, which ultimately causes polemics at the local level and leads to vertical conflicts. In Mochtar Kusumaatmad's legal view, which is explained through the study of Nurahmani and Sihombing [28], the law functions as an instrument to create order and order in development. Given that the essence of development is change, an effective control mechanism is the key to achieving regularity in implementing food estate development policies. Therefore, it is important to implement a comprehensive policy mechanism by developing control arrangements in the program implementation stage. This step is expected to mitigate the potential for abuse of power by local elites.

Financial Feasibility Analysis

Local communities in peatland areas, especially in Pulang Pisau Regency, have a distinctive way and culture in utilizing forests and land to meet their food needs and livelihood sources. This effort to use forests and land that has been carried out for generations shows a high level of responsibility and prioritizes the principles of sustainability based on local practices and knowledge that have been passed down from generation to generation. This local knowledge reflects the creative thinking and actions of various generations in adapting to the ecosystem, as well as facing changes in the socio-economic environment that continue to occur [29].

Through local wisdom, indigenous peoples in Indonesia are able to survive the various water resource crises they face [30]. In this context, compared to land management approaches that are not in accordance with the biophysical and socio-cultural conditions of the community, which often cause various losses in terms of economy, ecology, and society, a sustainable approach is very important. Sustainable peatland management not only involves modern technology and government policies but must also integrate local wisdom [31]. This study has examined various types of local plants that can support sustainable development in peatlands through a food plantation forest management scheme based on local plants.

The results of this study explain various types of local plants cultivated by the community in peatland areas. Peatland itself is a very vulnerable type of marginal land, so its management needs to be carried out carefully and responsibly. Under such conditions, there are not many types of plants that can be developed with significant economic potential at this study site. However, there are seven types of local plants that have been developed by the community, which offer promising business potential. Furthermore, an analysis is carried out to evaluate the feasibility of developing various businesses from a financial perspective.

The results of the analysis show that eucalyptus oil has a higher NPV value than other plants. Eucalyptus oil offers a high selling value, relatively low maintenance costs, and ease of seeding that allows it to be done independently without the need to buy seedlings. In addition, eucalyptus oil has been proven to be developed not only in Central Kalimantan, but also in various other regions, such as in the Pilot Project for eucalyptus oil development in East Biak Regency and other locations. Overall, the analysis in the study showed seven types of plants were feasible to develop. Among all these types, eucalyptus oil refining businesses are considered the most profitable and feasible to run. Integrating informal and formal knowledge, as well as the experiences of farmers, is essential to ensure sustainability and resilience in agriculture [32].

Multidimensional Analysis of Sustainability

To achieve sustainable development that is able to integrate economic and conservation interests, as well as adaptive to the socio-cultural conditions of the community, this study conducts a multidimensional analysis using Rapfish analysis. The objective is to assess the sustainability of seven crop types planned to be developed through various sustainable peatland management scenarios.

In terms of ecology, seven types of plants managed by communities in peatlands show a fairly good sustainability index for each type of plant (Table 3). Overall, the sustainability of food plantation forest management from an ecological perspective at the study location is in the category of quite sustainable with a value of 62.90%. However, there is a significant difference when compared to the results of the study which shows the index value for the ecological dimension in the peat swamp forest ecosystem of the Kampar Peninsula, which was recorded at only 33.37. The index value is lower than the sustainability value achieved

by local communities in the ex-PLG area of Central Kalimantan. However, the index value in this dimension needs to be increased by paying attention to sensitive attributes that affect the value of the sustainability index in the ecological dimension.

Based on the analysis carried out, there are four attributes that are classified as sensitive, namely: a) intensity of land fires, b) use of ameliorants/fertilizers, c) subsidy rate, and d) land and water management. These findings are in line with the results of key factors in the index of peatland management sustainability in the ecological dimension, which include: (1) Water management, (2) Land fires, (3) Drought, and (4) Land subversion [33]. Therefore, these attributes need to be considered and managed wisely in order to achieve sustainable forest and peatland management.

The intensity of peatland fires managed by local communities for timber forest products, non-timber forest products, MPTs, and food crops is relatively low. This is due to the high attention of the community to the sustainability of the land they manage. Land management that prioritizes local wisdom has proven to be effective in suppressing the rate of land subsidence. One of the physical aspects that need to be considered in peat development for annuals or plantations is the level of subsidence (land subsidence) [34]. To maintain or even increase sustainability value, this attribute needs to be a key consideration in policy interventions [35]. In addition, the ability of farmers to manage water for horticultural crop cultivation in shallow peatlands, especially in the regulation of groundwater level, is also a key factor to achieve success [36].

Economically, increasing the sustainability of food plantation forests can be achieved through improvements in labor absorption. The results of interviews in the field show that local communities generally have land with varying areas, ranging from 2 to 5 ha. However, the land managed for food crops is relatively small, so land management is often carried out independently by family members. On the other hand, limited market access makes farmers reluctant to expand the land they manage, so their contribution to labor absorption is very minimal. Providing opportunities for farmers to manage food plantation forests on a larger scale, accompanied by increased market access, is expected to trigger the enthusiasm of farmers to develop food plantation forests more optimally.

Although farmers who cultivate leased rice fields tend to operate more intensively than those who manage their own land, this only has an impact on increasing agricultural production related to income, especially to cover land rental costs [37]. In terms of land ownership, the community still faces the problem of lack of legal guarantees related to the rights to the land they manage. The management of forests and peatlands by local communities is their main source of livelihood. In the ex-PLG region, about 80% of the community relies on farms, plantations, or plantations, with most of them managing two to three different plots of land for different types of crops. This can help overcome farmers' financial crises when they experience crop failure. Therefore, in order to realize the improvement of community welfare, concrete steps are needed to increase sensitivity to attributes that affect the sustainability of forest and peatland management by local communities. This effort is also closely related to the conservation activities that will be carried out. Historically, community groups in conservation areas have interacted with and depended on forest resources, even their cultures growing, taking root, and developing through their relationship with these forests [38]. If the economic improvement aspects of the community are not integrated in conservation activities, this has the potential to become a problem and a threat to the area to be protected.

In the social dimension, the analysis shows that forest and peatland management is at a fairly sustainable status. Overall, crops managed by the community show a fairly sustainable sustainability index. However, there is one type of plant whose index results show unsustainability, namely rubber plants (<50%). Based on the results of interviews with rubber tappers, the factors that cause rubber to no longer be a leading commodity are: a) price factors that are always falling and unstable; b) the quality factor of the rubber produced is not able to compete with synthetic rubber; c) public knowledge in producing rubber with high selling value; and d) inadequate market access. Unlike rubber plants, chilli plants have a higher sustainability index value compared to other types of crops; this is due to the high level of demand from mid-2022 to early 2023, when the price of chilli reached IDR 60,000 kg^{-1}, even though there was a decrease in the price of chilli to IDR 25,000 kg^{-1} in mid-2023, this will not have much impact on chilli farmers because, in addition to being sold, chilli peppers are also grown for their own consumption, so chilli plants are superior to other plants from social aspects.

The intensity of conflicts related to land managed by local communities in the ex-PLG area is very rare. Although sometimes conflicts do occur, usually, this does not have the potential to cause significant conflicts. Based on interviews with local communities, land conflicts that arise can generally be resolved through customary mechanisms. This can be seen from one of the sensitive attributes in the analysis of the social

dimension lever, namely the existence of customary rules and local wisdom. Village communities tend to comply with customary norms that govern land ownership, especially customary land that is inherited from generation to generation. Land tenure status shows a unique diversity in village communities, one of which is strongly influenced by indigenous factors [39].

In addition, product marketing opportunities are also a sensitive attribute. According to the results of the interviews, the community feels considerable benefits from galam wood, which offers marketing opportunities for both personal and economic needs. The community's dependence on galam wood is quite high. However, this dependence is different from the condition of the people in South Sumatra. BP2HLK Banjarbaru found that in the region, many landowners prefer to convert the galam timber forest that grows naturally on their land, in order to ensure ownership rights to the land resources they own.

Index Sensitivity Test and Sustainability Status

Based on the analysis related to forest and peatland management in three dimensions—ecological, economic, and social—it can be concluded that the ecological dimension has the highest sustainability index, followed by the social dimension. In contrast, the economic dimension has the lowest index. However, there is no single dimension that can be categorized as bad. The concept of sustainable development does not mean that all dimensions have the same index value. Still, in the condition of a region, there must be a more dominant dimension that is a priority of attention [39]. In addition, the validity test results in the Multidimensional Scaling (MDS) analysis showed good stress values (<25 or 25% and (R2) close to 1 or 100%) for these three dimensions, indicating that the accuracy of the results of this analysis can be accounted for.

Monte Carlo analysis was also carried out to assess the magnitude of error factors or errors in the analysis; the comparison of the results of the MDS analysis with the Monte Carlo analysis was relatively small (<5%). This confidence interval analysis explains: 1) the error in assessing each attribute is relatively small; 2) the variation in assessment due to differences of opinion is relatively small; 3) the analysis process that is carried out repeatedly is stable; 4) errors in entering lost data can be avoided [40]. Thus, the Rap-Peat method, a modification of the Rap-fish produced in this study, can be applied in formulating policies and programs for sustainable food crop management in peatlands. These findings confirm that forest and peatland management practices carried out by local communities are very feasible to implement and develop in the future.

Best Scenario

The results of the multidimensional financial feasibility and sustainability analysis show that the seven types of crops are feasible to develop. Therefore, the final stage of this study is to determine the best scenario. In this study, scenarios have been prepared by integrating various types of plants into land management to find optimal food plantation forest management scenarios through normative and exploratory approaches. As part of the decision-making process, which begins with a description of existing conditions, this study identifies three determining factors, namely: the intensity of land fires (ecological dimension), local employment (economic dimension), and the intensity of land conflicts (social dimension). These findings suggest that the more policies that do not support expanding forest and peatland conversion, the higher the rate of fires and land degradation.

On the other hand, the lack of support for land management policies following the local community's social and cultural conditions will cause the absorption of local labor to be low. In addition, the lack of stringent policies and control mechanisms to ensure equitable and inclusive benefits can potentially increase the intensity of land conflicts. Based on these findings, the best scenario proposed in this study is to maintain the function of the area by integrating various local commodities (scenario IV) and reviewing spatial planning policies that are more favorable to the local community in the ex-PLG area of Central Kalimantan. Agroforestry systems can increase harvest intensity, maintain soil fertility, and increase farmers' incomes by sustainably combining forestry and agricultural elements [41].

Conclusion

The peatland management model for food security using a food estate approach in the Former Peatland Development (Ex-PLG) area has given rise to horizontal conflict due to the absence of a control mechanism in implementing the prospective farmers' land (CPCL) food estate extension program. The financial feasibility analysis and ecological, economic, and social sustainability analysis show that the seven types of food crops managed by local communities are feasible and are on the quite sustainable index. To improve the

multidimensional sustainability position, the top three important variables were obtained: land fire intensity (ecological dimension), local labor absorption (economic dimension), and land conflict intensity (social dimension). The best scenario in managing food plantation forest land is scenario IV (agroforestry of eucalyptus oil, rubber, MPTs, and food crops). Maintaining regional functions by integrating various local commodities (scenario IV), as well as reviewing spatial planning policies that favor local communities in the ex-PLG area of Central Kalimantan is the best scenario proposed by this research.

Author Contributions

SD: Conceptualization, Methodology, Software, Investigation, Writing - Review & Editing; **BK**: Review, Conceptualization, Methodology, Supervision; **RM**: Review, Conceptualization, Methodology, Supervision.

Conflicts of Interest

There are no conflicts to declare.

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