Vol. 14, No. 6 (2025): 2069 - 2079 http://dx.doi.org/10.23960/jtepl.v14i6.2069-2079

JURNAL TEKNIK PERTANIAN LAMPUNG

ISSN 2302-559X (print) / 2549-0818 (online)
Journal homepage : https://jurnal.fp.unila.ac.id/index.php/JTP

Economic Feasibility of Embankment Construction with a Polder System for Optimizing Sustainable Palm Oil Cultivation

Hermantoro[1], Fahmi W. Kifli[1], Rolly Marta[1,✉], Risca Permatasari Nurfrizal[2], Wandha Atmaka Aji[3]

[1] Master Program in Plantation Management, STIPER Institute of Agriculture, Yogyakarta, INDONESIA.
[2] Lecturer in the Agribusiness Study Program, Faculty of Agriculture, Antarkusuma University, INDONESIA.
[3] Lecturer in the Nursery Study Program at the Yogyakarta Plantation Community Academy, INDONESIA.

Article History:

Received : 17 July 2025
Revised : 24 August 2025
Accepted : 30 August 2025

Keywords:

Investment Feasibility,
Low Land,
Palm Oil,
Polder System,
Productivity.

Corresponding Author:
✉ rollymarta86@gmail.com
(Rolly Marta)

ABSTRACT

Lowland areas in oil palm plantations is often flooded due to river overflows and high rainfall, which results in reducing oil palm productivity. This research aims to analyze the feasibility of investing in building embankments with a polder system to optimize lowland areas for sustainable oil palm cultivation. The research method uses a quantitative descriptive approach with financial analysis based on NPV, IRR, PP, PI, BCR and BEP parameters. The research results show that the polder system increases land productivity from 60–61% utilization to 100%, with an optimal projection of 136 trees/ha. Even though investment costs increased from IDR 11.8 billion to IDR 14.4 billion, the financial feasibility analysis resulted in a positive NPV of IDR 964,200,861, IRR 22.20% (> 20% discount), PP 10 years, PI 2.17 > 1, BCR 1.21 > 1 and BEP achieved in 10 years. In conclusion, building embankments with a polder system is financially and technically feasible, increasing productivity while reducing the risk of flooding. Recommendations include regular monitoring of the polder system and integration with sustainable cultivation practices.

1. INTRODUCTION

Palm oil is a strategic commodity for the Indonesian economy, especially in meeting global demand for the food, energy and derivative products industries. Soil and climate conditions as well as plant management greatly influence the growth and yield of oil palm plants (Harahap *et al*., 2022; Woittiez *et al*., 2017). The cultivation of oil palm in lowland areas faces serious challenges, such as waterlogging and low soil fertility, poor drainage, high salinity, and potential pyrite content, which threaten the productivity and sustainability of cultivation, as well as greater investment in oil palm plantation management, particularly in infrastructure development (Pahan, 2006; Akbar *et al*., 2023). For example, Akbar *et al*. (2023) reported that oil palm cultivated lowland areas affected by sea tides produced lower growth, fruit tonnage, and weight per bunch than those on mineral soil. Similarly, Nasution (2023) also found the growth and production of oil palm on land that experienced flooding was lower than those of plants without affected by flooding. Oil palm growth and production in lowland areas are influenced not only by soil fertility but also by water management in those areas (Winarna *et al*., 2017).

Lowland areas in oil palm cultivation face a number of complex challenges that have the potential to reduce productivity and increase operational costs (Lydiasari & Santoso, 2022). The main challenges are poor drainage and waterlogging, which can cause anaerobic stress on the roots, inhibit growth and even trigger plant death. This waterlogged soil condition also accelerates the rate of subsidence (lowering of the land surface). From an operational aspects, including land accessibility for cultivation, maintenance, harvesting, and transporting fresh fruit bunches become more difficult, especially during the rainy season. These areas require greater infrastructure investment and increasing drainage maintenance costs.

To overcome this problem, a cluster-based polder system can be implemented. A polder system is hydrologically separated from its surroundings, either naturally or artificially, and equipped with physical facilities, which include embankments, internal drainage systems, retention ponds or reservoirs, pumps and water gates (Menteri PU, 2014; Kementerian PUPR, n.d), which are controlled as one management unit (Nugroho *et al*., 2016). Polder technology is used as a flood control system on lowland areas. By using a network of canals and pumps, this system can control groundwater levels according to the needs of oil palm plants, while preventing land degradation (Wicaksono, 2021). This system is considered effective in optimizing water management in lowland areas, especially in areas with topography 29 meters above sea level which are vulnerable to hydrological fluctuations (Kodoatie & Sugiyanto, 2002). As stated in the Regulation of Agriculture Minister 38-2020, the implementation of good plantation practices, environmental and natural resources management are important elements in realizing sustainable oil palm plantations (Menteri Pertanian, 2020). Currently, sustainability issues are very important for palm oil plantations in relation to the global challenge of rejection of Indonesian palm oil commodities which are considered unsustainable (Ronauly, 2024). Awareness of environmental sustainability is believed to make the future of Indonesian palm oil more prospective (Astuti *et al*., 2014). However, investment in building embankments and supporting infrastructure requires high costs, including construction, operation and maintenance, so its feasibility needs to be assessed financially (Gittinger, 1982).

According to Rangkuti (2012), investment feasibility analysis is a systematic and in-depth assessment process of an investment plan to determine its feasibility to be implemented. Lowland areas faces challenges, such as risk of flooding, poor drainage systems, and the need for greater initial capital for land preparation. Each aspect has an important role in determining the success of a business plan (Umar, 2000). A business feasibility study not only assesses whether a business is worth building, but this study can also evaluate its feasibility when operated regularly in order to achieve maximum profits in an unlimited period of time (Suliyanto, 2010). According to Primyastanto (2016), a feasibility study or business feasibility study is a study carried out to assess agencies on certain projects that are being or will be implemented. Meanwhile, Nurmalina *et al*. (2023) stated that business feasibility studies basically aim to assess the feasibility of a business based on investment criteria. This analysis is important to ensure that the project not only increases land productivity, but also meets sustainability principles (RSPO, 2013). In addition to financial benefits such as savings in maintenance costs and increased crop yields, this project is expected to contribute to academic literacy regarding lowland management and provide practical recommendations for industry. This research aims to analyze investment and operational costs before and after embankment construction, as well as evaluating the feasibility of the polder project through the parameters NPV, IRR, PP, PI, BCR and BEP. Results of this research is expected to contribute as reference to develop sustainable oil palm plantations on lowland areas, especially in areas with high hydrological vulnerability.

2. MATERIALS AND RESEARCH METHODS

2.1. Research Location

The research was conducted at PT. Menthobi Makmur Lestari (PT. MMaL), in Lamandau Regency, Central Kalimantan Province, at coordinates 2°12'52.50"S and 111°22'59.32"E (see Figure 1). This location has a topography dominated by flat to gentle areas with slopes of 0–8%, accompanied by a small number of areas with moderate slopes of 8–15% and 15–25%, and only a very small amount of land that falls into the steep category of 25–45%.

As one of the plantation companies in this region, PT. MMaL experienced a significant impact due to high rainfall and back flow from the Lamandau River, which inundated 2,500 hectares of land. This condition poses a high risk to oil palm plants, where prolonged waterlogging can cause suboptimal plant growth or even result in death. Based on Table 2, it can be explained that if the water level of the Lamandau River exceeds the level of 350 cm, there will be back flow entering the garden area. This condition indicates the potential for inundation due to the back pressure of river water on the plantation drainage system, thus requiring good hydrological management to prevent negative impacts on land productivity. To address this issue, PT. MMaL implements a cluster-based polder system (Polder A, B, C, D) and currently has completed polder A.

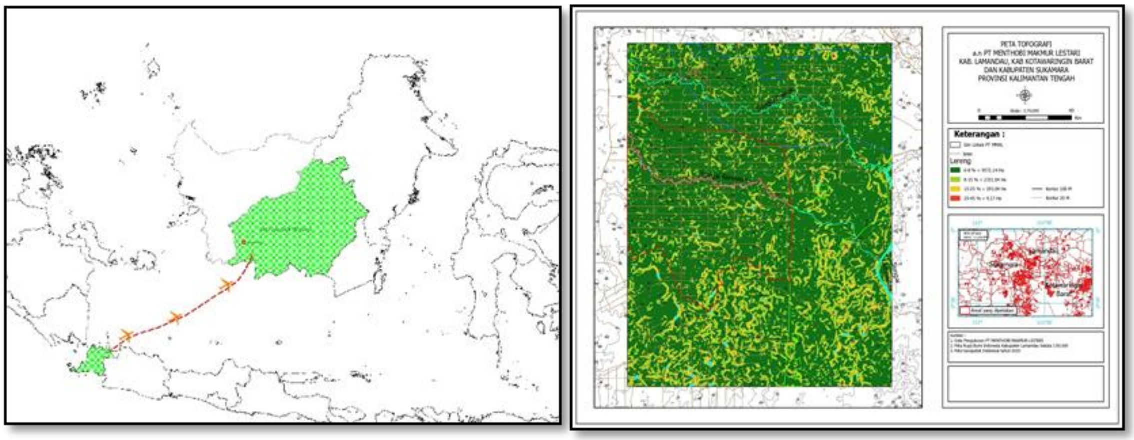

Figure 1. Research location and topographic map

2.2. Research Plan

Figure 1 presents the work flow of this research which was carried out from March to May 2025. The design of this research is descriptive quantitative research with a survey method approach, namely carrying out critical observations and investigations to obtain accurate information regarding a particular problem and object in a community group or location to be studied. In this research, the variables observed include investment costs, operational costs, and revenue benefits. Investment costs include expenses for building a polder system, including planning, land acquisition, infrastructure development, as well as procurement of supporting equipment and technology, which determines the feasibility of the project because it affects the return on investment period and the efficiency of the system in dealing with floods. Operational costs include infrastructure maintenance, water pump management, labor, and energy costs to maintain system sustainability, so their evaluation is important to ensure long-term financial efficiency. The benefits reflect economic and social benefits such as increased land value, reduced flood risk, as well as increased economic productivity and corporate welfare, which are evaluated to assess whether the positive impact of the polder system exceeds the costs incurred to determine the feasibility of implementing the project.

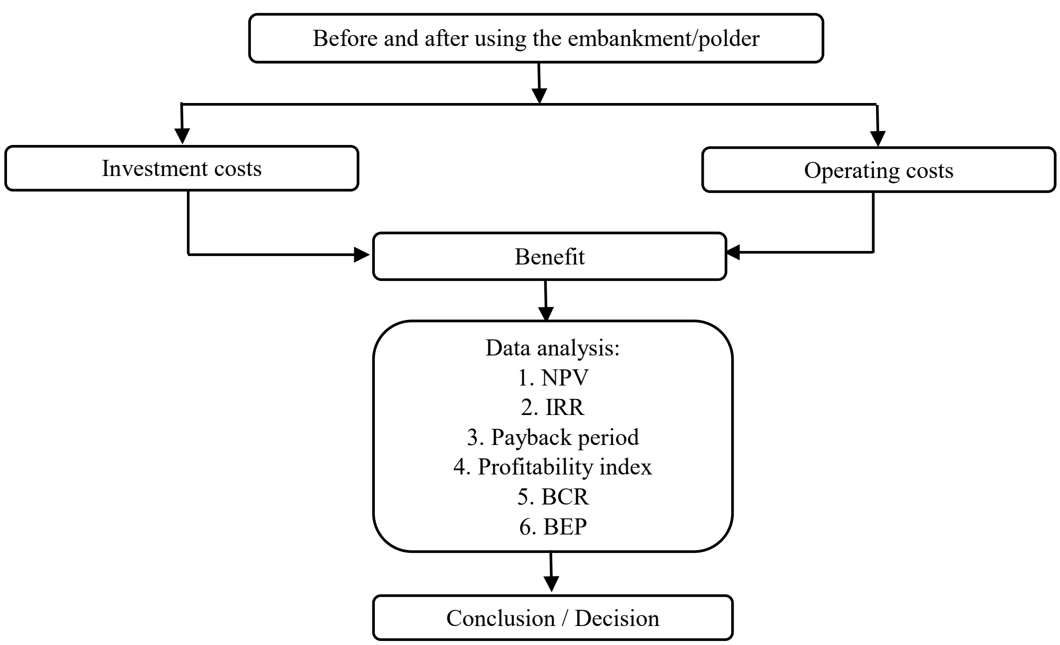

Figure 2. Research Plan

Table 1. Rainfall Data from 2007 to 2024 (mm)

No.	Month	Year																		Mean
		2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	
1	January	261	145	133	292	308	288	119	82	201	375	44	206	206	307	120	116	45	228	184
2	February	180	67	147	389	145	221	271	131	197	329	165	132	458	346	9	44	24	310	198
3	March	214	249	359	332	204	157	188	335	253	490	139	230	216	306	21	58	72	371	233
4	April	408	303	354	283	299	355	406	334	248	412	347	334	387	333	197	148	162	293	311
5	May	270	271	343	256	204	307	210	324	158	172	205	210	157	288	148	145	171	176	223
6	June	196	178	74	412	23	61	97	199	91	99	132		169	189	34	273	93	321	155
7	July	163	207	158	284	139	136	220	52	25	43	175	55	10	102	25	256	394	157	144
8	August	143	299	107	604	1	304	285	300	9	150	124	13	49	59	201	335	43	253	182
9	September	203	188	25	446	147	19	295	39		171	144	115	34	49	82	596	68	174	164
10	October	375	368	354	396	383	380	132	51	68	271	199	131	198	47	95	389	132	188	231
11	November	349	355	400	475	406	483	248	399	219	246	262	242	133	152	83	279	439	549	318
12	December	209	363	375	213	558	463	360	625	287	262	358	235	245	57	93	60	310		298
Total		2,971	2,993	2,829	4,380	2,815	3,174	2,831	2,871	1,756	3,017	2,293	1,743	2,260	2,235	1,105	2,698	1,952	3,018	
Average		248	249	236	365	235	264	236	239	160	251	191	158	188	186	92	225	163	274	

Table 2. Water level altitude data of Sei Lamadau 2020 – 2024

Month	2020			2021			2022			2023			2024		
	Max	Median	Min	Max	Median	Min	Max	Median	Min	Max	Median	Min	Max	Median	Min
January	532	403	312	335	277	105	388	238	114	344	135	60	652	436	200
February	525	425	278	290	114	62	582	355	84	194	106	34	572	420	178
March	635	507	202	250	163	12	318	160	68	670	566	206	606	470	270
April	530	413	244	235	135	72	316	241	74	490	360	160	676	560	412
May	500	365	270	600	486	195	510	434	290	400	244	56	710	580	512
June	760	343	200	500	318	160	670	345	150	500	228	38	678	554	280
July	807	673	490	624	360	110	627	399	200	660	566	76	566	259	50
August	405	270	130	690	306	60	610	400	160	180	58	-	608	206	90
September	794	675	125	740	634	342	702	605	548	210	-	-	650	413	170
October	690	560	245	618	540	378	798	690	528	160	-	-	662	486	192
November	613	491	360	628	523	340	640	471	200	588	260	50	698	507	172
December	480	202	135	408	300	205	650	395	160	566	406	210	690	302	186

2.3. Data Analysis

In assessing financial feasibility, several common methods used are Net Present Value (NPV), Internal Rate of Return (IRR), Payback Period (PP), and Profitability Index (PI), Benefit-Cost Ratio (BCR), Break Even Point (BEP). Analysis of the feasibility of investing in embankment construction with a polder system is carried out using the following method:

2.3.1. Net Present Value (NPV)

NPV is used to calculate the difference between the present value of cash inflows and the present value of cash outflows. If the NPV result is positive, then the investment is considered profitable. NPV was calculated as follows.

$$NPV = \sum \frac{C_t}{(1+r)^t} - C_0 \tag{1}$$

where C_t is net cash flow in year t, C_0 is initial investment, r is discount rate or expected rate of return, and t is reference year.

2.3.2. Internal Rate of Return (IRR)

IRR is the discount rate that makes the NPV zero. If the IRR is higher than the minimum expected rate of return, then the investment is worth running. IRR was calculated according to the following equation.

$$IRR = i_1 \frac{NPV_1}{NPV_1 - NPV_2}\ x\ (i_2 - i_1) \tag{2}$$

where i_1 and i_2 is respectively discount rate that produces a positive NPV_1 negative NPV_2.

2.3.3. Payback Period (PP)

Payback Period shows how long the investment will return in the form of net cash flow. The shorter the payback period, the more worthy the investment. Payback Period (PP) was calculated according to Equation (3):

$$PP = \frac{Initial\ Investment}{Annual\ Cash\ Flow} \tag{3}$$

2.3.4. Profitability Index (PI)

Profitability Index is the ratio between the present value of cash inflows to the initial investment. If the PI value is greater than 1, then the investment is worth making. A higher PI indicates a more profitable investment. PI was calculated according to Equation (4):

$$PI = \frac{\sum \frac{C_t}{(1+r)^t}}{C_0} \tag{4}$$

2.3.5. Benefit-Cost Ratio (BCR)

Benefit-Cost Ratio (BCR) is a ratio used to assess the economic feasibility of an investment or project by comparing the benefits obtained with the costs incurred. If the BCR value is greater than 1, then the project is considered feasible because the benefits are greater than the costs. BCR was calculated according to Equation (5):

$$BCR = \frac{\sum PV\ Benefits}{\sum PV\ Cost} \tag{5}$$

where PV is present value. If BCR > 1, the project is feasible, and vice versa. If BCR = 1 then the project break-even.

2.3.6. Break Even Point (BEP)

In the context of constructing a polder system embankment on lowland areas, the Break Even Point (BEP) is the point at which the total income or benefits obtained from the polder system are equal to the total investment and operational costs incurred. The BEP in this project determines when investment in the construction of polder embankments begins to produce economic benefits equivalent to the costs incurred. If the project reaches BEP in a relatively short time, then the polder system can be considered economically feasible. The benefits calculated in the BEP can be: (a) Increased land value due to reduced risk of flooding; (b) Economic benefits from increased agricultural, residential, or industrial productivity after land protection from flooding; and (c) Cost savings due to reduced damage to infrastructure and assets due to waterlogging. Meanwhile, the costs taken into account include: (a) Initial investment costs for the construction of the embankment and polder system; and (b) Operational and maintenance costs include pumps, drainage and labor. The BEP for the polder project was calculated as follows:

$$BEP\ (Year) = \frac{Total\ Investment\ Costs + Annual\ Operating\ Costs}{Annual\ Economic\ Benefits\ from\ Polder} \tag{6}$$

If the results are smaller than the planned life of the project, then the project is considered feasible. While, if the yield is greater than the life of the project, the project is less economically viable.

3. RESULTS AND DISCUSSION

3.1. Investment and Operational Costs

Investment is the sacrifice of current resources in order to gain future profits. According to Nurmalina *et al*., 2020, investment is an activity whose speed of return can be measured analytically. According to Rangkuti (2012), investment feasibility analysis is a systematic and in-depth assessment process of an investment plan to determine its feasibility to be implemented. A business feasibility study not only assesses whether a business is worth building, but this study can also evaluate its feasibility when operated regularly in order to achieve maximum profits in an unlimited period of time (Suliyanto, 2010). From Table 3 below, regarding the comparison of investment and operational costs, embankment construction has had a positive financial and operational impact, even though the initial investment increased from IDR.11,823,062,550 to IDR.14,945,572,602, the increase in investment costs from the start is infrastructure work related to embankment construction. Annual operational costs are relatively stable from IDR.22,619,466,530 to IDR.24,729,282,289. In addition, the previously high risk of flood damage was reduced to low after the construction of the embankment in Polder A. This shows that this project not only increases long-term cost efficiency but also provides better protection against potential damage. Thus, embankment construction is an effective step to optimize risk management and financial resources.

Table 3. Comparison of investment & operational costs before and projections after the project

Component	Before Project	After Project
Year	2016 – 2024	2025 – 2032
Initial Investment (IDR)	11,823,062,550	14,945,572,602
Operational/Year (IDR)	22,619,466,530	24,729,282,289
Damage Risk	High (flood)	Low (controlled)

3.2. Palm Oil Production

Based on SPH (stand per hectare) analysis before and after the project as explained in Table 4, it reveals significant differences in land productivity. In the period before, namely 2016 - 2019, the SPH value only reached 16,666 - 17,069 with a utilization rate of 60% - 61%, which shows that productivity has not met the optimal standard of 136 trees/ha. This indicates that there is inefficiency in land use caused by land condition factors in lowland areas. In the 2020 – 2023 project transition phase, land utilization dropped drastically to 26%, which could be caused by floods that inundated the area. However, after this mitigation project is completed, long-term projections can re-optimize the land previously with SPH plants according to the standard of 136 trees/ha in Table 4.

Based on a comprehensive analysis of PT. palm oil production data. Menthobi Makmur Lestari, especially in Polder A which was affected in an area of 206 hectares, this research reveals the significant impact of implementing mitigation projects on production performance. Historical data for the 2016-2024 period shows pre-project or pre-intervention conditions characterized by low productivity, clearly indicating serious problems in the oil palm cultivation

Table 4 Palm oil SPH before project and the projected SPH after project

Year	Area affected by flood (ha)	Number of tree	SPH*	Percentage SPH (%)
SPH before the project				
2016 (TBM 0)	206	16,666	81	60%
2017 (TBM 1)	206	16,860	82	60%
2018 (TBM 2)	206	17,069	83	61%
2019 (TBM 3)	206	17,069	83	61%
2020 (TM 1)	206	17,069	83	61%
2021 (TM 2)	206	7,330	36	26%
2022 (TM 3)	206	7,330	36	26%
2023 (TM 4)	206	7,330	36	26%
Average before project	206	13,340	65	48%
SPH projection after the project				
2025 (TBM 0)	206	27,950	136	100%
2026 (TBM 1)	206	27,950	136	100%
2027 (TBM 2)	206	27,950	136	100%
2028 (TBM 3)	206	27,950	136	100%
2029 (TM 1)	206	27,950	136	100%
2030 (TM 2)	206	27,950	136	100%
2031 (TM 3)	206	27,950	136	100%
2032 (TM 4)	206	27,950	136	100%
Average after project	206	27,950	136	100%

Note: *) SPH = stand per hectare. The percentage SPH was calculated based on standard or optimum number of 136 trees/ha.

Table 5. Production before the project and projected production after the project

Year Production before the project	The area of land affected by inundation (ha)	FFB Production (Ton/year)	Productivity (Ton/ha/year)
2016 (TBM 0)	206	-	-
2017 (TBM 1)	206	-	-
2018 (TBM 2)	206	-	-
2019 (TBM 3)	206	-	-
2020 (TM 1)	206	127	0,62
2021 (TM 2)	206	240	1,17
2022 (TM 3)	206	325	1,58
2023 (TM 4)	206	339	1,65
2024 (TM 5)	206	373	1,81
Total	206	1,403.91	
Production Projections after the project			
2025 (TM 6)	206	447	2,18
2026 (TM 7)	206	537	2,61
2027 (TM 8)	206	644	3,14
2028 (TM 9)	206	773	3,76
2025 (TBM 0)*	206	-	-
2026 (TBM 1)*	206	-	-
2027 (TBM 2)*	206	-	-
2028 (TBM 3)*	206	-	-
2029 (TM 1)*	206	1,285	6,25
2030 (TM 2)*	206	2,068	10,06
2031 (TM 3)*	206	2,385	11,6
2032 (TM 4)*	206	2,852	13,88
Average after project	206	10,991	

system due to inundation. The analysis results in Table 5 show the transformation in production performance after the implementation of the inundation mitigation project. In the period before the 2020-2024 project, production of fresh fruit bunches (FFB) only reached 127-373 tonnes/year, with a yield of 0.62-1.81 tonnes/ha/year, while in the period after the project (2025-2032 projection) production increased to 447 – 2,852 tonnes/year with a yield of 2.18 – 13.88 tonnes/ha/year in Table 5. According to Pahan (2012), oil palm production is influenced by the interaction of three main factors, namely genetic factors (seeds), environmental factors (agroclimate), and human factors (management). Genetic factors determine the highest production potential that can be achieved by plants. Environmental factors, such as land suitability (climate, topography and soil), water availability, and pest and disease attacks, greatly influence the realization of genetic potential. Meanwhile, the human factor through the application of appropriate cultivation techniques—including fertilization, plant maintenance, harvesting, and garden management—is the final determinant in optimizing the two previous factors to achieve maximum and sustainable results.

3.3. Investment Feasibility

Investment feasibility of the polder system mitigation project at PT. Menthobi Makmur Lestari specifically in polder A can be seen from the following criteria, namely Net Present Value (NPV), Internal Rate of Return (IRR), Payback Period (PP), Profitability Index (PI), Benefit-Cost Ratio (BCR), and Break Even Point (BEP). Based on the research results in Table 6, analysis of the feasibility of investing in the Polder A mitigation project at PT. Menthobi Makmur Lestari shows that this project is feasible to run based on all the financial indicators used. Net Present Value (NPV) is IDR. 964,200,861 > 0, proving that the project is able to generate positive cash flow after taking into account the time value of money, so that it can contribute a benefit to the company. Positive NPV means the project is able to generate net profit after taking into account the time value of money and investment costs.

Table 6. Criteria for Feasibility Analysis of Investment in Embankment Construction Projects

Analysis Criteria	Calculation Result	Benchmark Value	Remark
Net Present Value (IDR)	964,200,861	> 0	Feasible (positive)
Internal Rate of Return (IRR)	22.20%	> 20% (hurdle rate)	Feasible (exceeds)
Payback Period (PP)	10 Years	< 15 years (maximum)	Feasible (faster)
Profitability Index (PI)	2.17	> 1	Feasible (profitable)
Benefit-Cost Ratio (BCR)	1.21	> 1	Feasible (benefit > cost)
Break Even Point (BEP)	10 years	15 years (maximum)	Feasible

The IRR of 22.20% which exceeds the hurdle rate of 20% indicates that the project is able to produce a higher level of return on investment compared to the cost of capital or other investment alternatives with similar risks. With an Internal Rate of Return (IRR) that exceeds the benchmark, this project is considered financially feasible because it provides greater profits than the minimum requirements. Apart from that, the high Internal Rate of Return (IRR) also reflects investment efficiency, every rupiah invested can produce significant results. The Payback Period (PP) is 10 years, which is shorter than the maximum limit of 15 years, reflecting the project's ability to return investment capital in a relatively short time, thereby reducing financial risk. The sooner the PP is reached, the sooner investment funds can be realized, thereby reducing the period of uncertainty. Support for the feasibility of the project is further strengthened by the Profitability Index (PI) of 2.17 > 1, indicating that this project is very profitable and feasible to implement. A PI value of 2.17 means that every IDR 1 invested will generate IDR. 2.17 in the form of present value of future cash flows, reflecting very high investment efficiency. The high PI not only confirms that the benefits of the project far exceed the costs, but also indicates an extraordinary level of capital productivity. Thus, this project is not only feasible, but also included in the highly profitable investment category which is capable of providing returns of more than double the initial investment value.

The BCR analysis (Table 7) shows a BCR value 1.21 (> 1), confirms that the financial benefits of the project are significantly greater than the costs incurred. Based on the calculation, the BCR value identifies that the project is able to generate economic benefit of 25% higher than the total costs after discounting at a rate of 10%. The BCR value of 1.21 also reflects the resource efficiency of this project which is not only able to cover costs but also provides net profits. Thus, this project is considered financially feasible and provides added value for stakeholders.

Table 7. Benefit cost ratio (BCR) analysis

No.	Year	Benefits (IDR)	Cost (IDR)	Discount factor (1/(1+*r*)^*t*)	PV Benefits (10%)	PV Cost (10%)
1	2025	352,041,936	8,853,698,470	0.909	320,006,119	8,048,011,909
2	2026	435,123,832	1,917,838,568	0.826	359,412,285	1,584,134,657
3	2027	537,813,057	2,222,927,745	0.751	403,897,606	1,669,418,736
4	2028	664,736,938	1,951,107,819	0.683	454,015,329	1,332,606,640
5	2029	4,337,361,538	4,403,062,819	0.621	2,693,501,515	2,734,302,011
6	2030	7,191,727,699	5,383,811,604	0.564	4,056,134,422	3,036,469,745
7	2031	8,543,268,036	5,899,146,788	0.513	4,382,696,502	3,026,262,302
8	2032	10,521,068,078	6,612,403,495	0.467	4,913,338,793	3,087,992,432
9	2033	13,229,377,938	7,556,142,593	0.424	5,609,256,246	3,203,804,460
10	2034	14,253,310,160	7,978,165,762	0.386	5,501,777,722	3,079,571,984
11	2035	15,929,563,623	8,606,491,479	0.35	5,575,347,268	3,012,272,018
12	2036	16,425,604,984	8,870,341,698	0.319	5,239,767,990	2,829,639,002
13	2037	16,928,074,025	9,139,473,971	0.29	4,909,141,467	2,650,447,451
14	2038	17,519,329,499	9,439,643,086	0.263	4,607,583,658	2,482,626,132
15	2039	18,040,881,785	9,721,577,701	0.239	4,311,770,747	2,323,457,071
	Total				53,337,647,669	44,101,016,549
BCR:	1.21>1					

Break Even Point (BEP) which reaches 10 years < 15 years, which means that in the ninth year the total project income has equaled the total costs (both investment and operational). Achieving the Break Even Point (BEP) in a time faster than the maximum limit of 15 years shows that this project has operational efficiency and the ability to generate good income. The shorter the Break Even Point (BEP) time, the sooner the project will start generating net profits, thereby reducing financial risk to the company. Achieving Break Even Point (BEP) in 10 years also reflects a controlled cost structure and stable income flow, which further strengthens the project's feasibility from a financial sustainability aspect.

3.4. Sensitivity Analysis

Sensitivity analysis was carried out to assess the resilience of investments in embankment construction with a polder system to changes in oil palm production assumptions. The calculation results show that under normal production projection conditions, the project is declared feasible with an NPV of IDR 964,200,861, IRR 22.20%, PI 2.17, BCR 1.21, and a Payback Period of 10 years. When a simulation of a decrease in production of 5%, 10%, up to 15% is carried out as in Table 8, all financial indicators are still in a decent condition, even though there is a gradual decrease in the NPV, IRR, PI and BCR values as well as an extension of the Payback Period to 11-12 years. This indicates that the project can still accommodate fluctuations in production decline within this range with an adequate level of financial feasibility.

Table 8 Sensitivity analysis with declining production by 5% to 20%

Production Decline	NPV (IDR)	IRR (%)	Payback Period (Years)	PI	BCR	BEP (Years)
Normal Production	964,200,861	22.20	10	2.17	1.21	10
5%	487,653,679	19.86	11	1.85	1.16	11
10%	369,400,800	17.66	11	1.53	1.10	11
15%	166,602,158	15.28	12	1.22	1.05	12
20%	472,687,097	12.68	12	0.90	0.99	12

However, the critical point of feasibility occurs when the decline in production reaches 20%, where even though the NPV is still positive at IDR 472,687,097, the PI value drops to 0.90 (<1) and the BCR becomes 0.99 (<1). This condition indicates that financially the project is no longer feasible at this level of production decline. Thus, it can be concluded that investment in building a polder system embankment is relatively safe up to a 15% decline in production, but will become vulnerable if the production decline is more than 20%. These findings are important as consideration for decision makers and investors in assessing the margin of safety and the level of risk that may be faced in project implementation.

4. CONCLUSIONS AND RECOMMENDATIONS

Based on the analysis carried out, this research proves that the construction of the polder system at PT. Menthobi Makmur Lestari is a financially and technically feasible investment, with strong feasibility indicators including positive NPV IDR 964,200,861 at an interest rate of 20%/year, IRR 22.20%/year (exceeding the minimum rate of return of 20%), Payback Period of 10 years, Profitability Index (PI) 2.17, and Benefit-Cost Ratio (BCR) 1.21 at the interest rate 10%/year, indicating that every rupiah invested is able to generate significant profits, while in terms of productivity, the implementation of the polder system has succeeded in optimizing the use of lowland areas by increasing land utilization from 60–61% to 100% (SPH 136 trees/ha) as well as increasing annual FFB production from 0.62-1.81 tons/ha to 2.18–13.88 tons/ha (post-project projection), which not only increases plantation output but also reduces the risk of losses due to flooding, so that the effectiveness of the system in controlling waterlogging makes the land more stable for oil palm growth by achieving Break Even Point (BEP) in 10 years, showing the project's ability to balance investment costs and economic benefits while reducing long-term operational uncertainty, so it can be concluded that the construction of a polder system embankment not only answers technical problems in the field but also provides added economic value, worthy of wider implementation as a sustainable solution for managing lowland areas in the oil palm plantation sector, especially in areas with hydrological characteristics. similar.

Based on the results of this research, suggestions that can be given include: (1) regular monitoring and evaluation of the performance of the polder system, including the condition of embankments, pumps and drainage channels to ensure long-term function and anticipate potential damage; (2) integration with sustainable practices through the implementation of environmentally friendly cultivation such as the use of organic fertilizer, soil conservation, and planting cover crops to minimize environmental impacts while increasing land productivity; and (3) developing human resource capacity through technical training for staff and local workers in managing polder systems and modern agricultural technology to ensure operational sustainability independently and efficiently.

REFERENCES

Akbar, H., Rahayu, E., & Andayani, N. (2023). Kajian produktivitas tanaman kelapa sawit areal rendahan pasang surut di Batu Mulia Estate. *Agroforetech*, ***1***(3), 1319–1332.

Astuti, M., Hafiza, H., Yuningsih, E., Nasution, I.M., Mustikawati, D., & Wasingun, A.R. (2014). *Pedoman Budidaya Kelapa Sawit* (*Elais guineensis*) *yang Baik*. Direktorat Jenderal Perkebunan, Kementerian Pertanian.

BPS (Badan Pusat Statistik). 2023. *Statistik Perkebunan Indonesia: Kelapa Sawit*. Badan Pusat Statistik, Jakarta.

Gittinger, J.P. (1986). *Analisa Ekonomi Proyek-Proyek Pertanian* (Translated by S. Sutomo & K. Mangiri). UI-Press, Jakarta.

Gray. C., Simanjuntak, P., Sabur, L.K., Mospaitella, P.F.L., & Varley, R.C.G. (1992). *Pengantar Kelayakan Bisnis*. Gramedia Pustaka Utama. Jakarta.

Harahap, A.F.S., & Munir, M. (2022). Faktor-faktor yang mempengaruhi produktivitas kelapa sawit (elaeis guineensis jacq.) pada berbagai afdeling di Kebun Bah Jambi PT. Perkebunan Nusantara IV. *Jurnal Tanah dan Sumberdaya Lahan*, ***9***(1), 99–110. https://doi.org/10.21776/ub.jtsl.2022.009.1.11

Kementerian PUPR (Pekerjaan Umum Dan Perumahan Rakyat). (n.d). *Diklat Penanganan Drainase Jalan: Modul 4 – Perencanaan Sistem Polder dan Kolam Retensi*. Badan Pengembangan Sumber Daya Manusia, Satuan Kerja Pusat Pendidikan dan Pelatihan Jalan, Perumahan, Permukiman, dan Pengembangan Infrastruktur Wilayah. Kementerian Pekerjaan Umum dan Perumahan Rakyat.

Kodoatie, R.J., & Sugiyanto, S. (2002). *Banjir: Beberapa Penyebab dan Metode Pengendaliannya Dalam Perspektif Lingkungan*. Pustaka Pelajar, Yogyakarta.

Lydiasari, H., & Santoso, H. (2022). Mitigasi areal banjir pada perkebunan kelapa sawit di lahan gambut berdasarkan pemodelan

HEC-RAS 2D. *Jurnal Penelitian Kelapa Sawit*, ***30***(2), 109-122. https://doi.org/10.22302/iopri.jur.jpks.v30i2.188

Menteri Pekerjaan Umum Republik Indonesia. (2014). *Peraturan Menteri Pekerjaan Umum Republik Indonesia Nomor 12/PRT/M/2014 Tentang Penyelenggaraan Sistem Drainase Perkotaan*. Jakarta.

Menteri Pertanian Republik Indonesia (2020). *Peraturan Menteri Pertanian Republik Indonesia Nomor 38 Tahun 2020 Tentang Penyelenggaraan Sertifikasi Perkebunan Kelapa Sawit Berkelanjutan Indonesia*. Jakarta.

Nasution, M.S.P. (2023). Pengaruh banjir terhadap produktivitas TBS pada lahan rendahan perkebunan kelapa sawit di PT. Buana Adhitama Kebun Sapiri Estate. [*Undergraduate Thesis*]. Institut Pertanian Stiper, Yogyakarta.

Ningsih, V.Y., Jumiati, E., Karsiningsih, E., Laapo, A., Pamela, P., Latifa, D., J, A.D., Putri, D.D., Isaskar, R., Wulandari, Y.S., Dolorosa, E., Arianti, Y.S., Adriani, D., & Yodfiatfinda, Y. (2024). *Analisis Kelayakan Agribisnis*. (2nd ed.). CY HEI Publishing Indonesia, Yogyakarta.

Nugroho, H., Kurniani, D., Asiska, M., & Nuraini, N. (2016). Kajian kinerja sistem polder sebagai model pengembangan drainase Kota Semarang bagian bawah dengan balanced scorecard. *Media Komunikasi Teknik Sipil*, ***22***(1), 43-50. https://doi.org/10.14710/mkts.v22i1.12508

Nurmalina, R., Sarianti, T., & Karyadi, A. (2020). *Studi Kelayakan Bisnis* (Revised Edition). IPB Press, Bogor.

Pahan, I. (2006). *Panduan Lengkap Kelapa Sawit: Manajemen Agribisnis Dari Hulu Hingga Hilir*. Penebar Swadaya, Jakarta.

Primyastanto, M. (2016). *Evapro (Evaluasi Proyek): Teori dan Aplikasi pada Usaha Pembesaran Ikan*. UB Press. Malang

Rangkuti, F. (2012). *Studi Kelayakan Bisnis & Investasi: Studi Kasus* (Edisi I). Jakarta: PT Gramedia Pustaka Utama.

Ronauly, I.E. (2024). Perkebunan kelapa sawit Indonesia yang berkelanjutan. *Syntax Admiration*, ***5***(12), 5611-5624.

RSPO (Roundtable on Sustainable Palm Oil). (2013). *Principles and Criteria for Sustainable Palm Oil Production*. RSPO. Retrieved from https://www.rspo.org/wp-content/uploads/e4-rspo-principles-criteria-document-english.pdf

Suliyanto, S., & Oktaviani, H.S. (2010). *Studi Kelayakan Bisnis: Pendekatan Praktis* (Cet. 1). Yogyakarta: Andi..

Umar, H. (2000). *Studi Kelayakan Bisnis: Teknik Menganalisis Kelayakan Rencana Bisnis Secara Komprehensif* (2nd ed.). Gramedia Pustaka Utama, Jakarta.

Wicaksono, R. (2021). Pembangunan tanggul dan sistem polder dalam pengelolaan air di Perkebunan Kelapa Sawit. *Prosiding Seminar Nasional*.

Winarna, W., Santoso, H., Yusuf, M.A., Sumaryanto, S., & Sutarta, E.S. (2017). Pertumbuhan tanaman kelapa sawit di lahan pasang surut. *Jurnal Pertanian Tropik*, ***4***(1), 95–105.

Woittiez, L.S., van Wijk, M.T., Slingerland, M., van Noordwijk, M., & Giller, K.E. (2017). Yield gaps in oil palm: A quantitative review of contributing factors. *European Journal of Agronomy*, 83, 57–77. https://doi.org/10.1016/j.eja.2016.11.002