



Mapping Sustainability Risks and Opportunities in the Patchouli Agribusiness System Based on the Triple Bottom Line

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Abstract. This study aims to analyze the sustainability level of patchouli agribusiness systems using the Triple Bottom Line (TBL) framework and to map the risks and opportunities that influence their sustainability, as well as to formulate development strategies through SWOT analysis. The research was conducted in Patambanua Village, Bulo District, Polewali Mandar Regency, involving 100 respondents comprising farmers, distillers, traders, and stakeholders, selected using purposive sampling. Data were collected through questionnaires, semi-structured interviews, and field observations, then analyzed using sustainability index, risk-opportunity mapping, and SWOT analysis. Results show that the overall TBL sustainability index reached 3.44 (moderate category), with the social dimension scoring highest (3.51) and the environmental dimension lowest (3.38). Risk mapping identified seven high-risk factors, with limited market access as the highest risk (score 17.52), followed by high production costs (17.47) and labor shortages (17.35). Opportunity mapping found that farmer institutional strengthening (17.22), government support (16.94), and new technology adoption (16.91) are the main strategic opportunities. SWOT analysis resulted in five priority strategies: (1) strengthening farmer institutions and market access, (2) adopting modern cultivation and distillation technology, (3) improving capital access and production efficiency, (4) sustainable distillation waste management, and (5) developing derivative products and market diversification. These findings provide an evidence-based foundation for the development of sustainable patchouli agribusiness policies in Polewali Mandar.

Keywords: Agribusiness; Patchouli; Risk Mapping; Sustainability; Triple Bottom Line.

1. INTRODUCTION

Patchouli (*Pogostemon cablin* Benth.) is one of Indonesia's leading essential oil commodities and plays a strategic role in supporting national export performance. Patchouli oil is widely utilized in the perfume, cosmetic, pharmaceutical, and aromatherapy industries due to its unique fixative properties that enhance the longevity of fragrances. Indonesia is recognized as the world's largest producer and exporter of patchouli oil, supplying approximately 90% of global demand and contributing around 50–60% of the country's total essential oil exports (Putri et al., 2017; Rosiana et al., 2019). The increasing global demand for natural ingredients in personal care and cosmetic products has further strengthened the market prospects of patchouli oil, positioning patchouli agribusiness as a promising source of income and rural economic development (Swamy & Sinniah, 2015).

Beyond its contribution to export earnings, patchouli agribusiness plays an important role in creating employment opportunities, generating household income, and supporting rural livelihoods. For many smallholder farmers, patchouli cultivation represents an attractive agricultural enterprise due to its relatively high economic value and shorter harvesting cycle

compared to several other plantation crops. Consequently, the development of patchouli agribusiness is not only important from an economic perspective but also contributes to agricultural modernization, export diversification, and rural development initiatives.

Despite its strong position in the global market, the performance of Indonesia's patchouli agribusiness remains suboptimal. National production is concentrated primarily in several major producing provinces, including Aceh, North Sumatra, and West Sumatra, while other potential production areas continue to face various constraints related to cultivation practices, processing technology, market access, and institutional support (Ari et al., 2022). These limitations hinder productivity improvement and reduce the ability of local producers to fully benefit from the growing international demand for patchouli oil.

Polewali Mandar Regency in West Sulawesi Province is one of the regions with considerable potential for patchouli development. Favorable agroecological conditions and the availability of agricultural land have encouraged local communities to engage in patchouli cultivation and distillation activities (Harli, 2016; Resmiati, Sukmawati Abdullah, 2025). However, the existing production performance does not adequately reflect this potential. Data indicate that although Polewali Mandar has approximately 666 hectares of patchouli cultivation area, total production reaches only around 9 tonnes. This figure is considerably lower than that of Gorontalo Province, which produces approximately 12 tonnes from only 55 hectares of cultivated land (Jamil et al., 2021). Such disparities indicate significant productivity and efficiency issues within the local patchouli agribusiness system that require comprehensive assessment and targeted interventions.

The challenges encountered by patchouli farmers and other agribusiness actors extend beyond production-related issues. From an economic perspective, farmers frequently face unstable market prices, limited access to capital, high production costs, and low production efficiency. In addition, most patchouli products are marketed as raw materials or crude oil, resulting in limited value addition and reduced income opportunities for producers (Effendy et al., 2019; Zaman et al., 2024). These conditions weaken the competitiveness of patchouli agribusiness and increase its vulnerability to market fluctuations.

From a social perspective, the development of patchouli agribusiness is constrained by weak institutional capacity, limited managerial skills, and inadequate access to information, training, and extension services. Insufficient collaboration among farmers, distillers, traders, government agencies, and other stakeholders further reduces farmers' bargaining power and limits opportunities for innovation and market expansion (Anantanyu, 2011). Moreover, the

declining interest of younger generations in agriculture may pose additional challenges to the long-term sustainability of patchouli farming systems.

Environmental issues also represent a major concern in patchouli agribusiness development. Unsustainable cultivation and processing practices may threaten environmental quality and resource sustainability. Excessive use of chemical fertilizers and pesticides can contribute to soil degradation, while improper management of distillation waste may cause environmental pollution. At the same time, patchouli distillation waste possesses significant potential for further utilization, such as organic fertilizer production or other value-added applications. Therefore, improving environmental management practices is essential for ensuring the long-term sustainability of patchouli agribusiness (Aryani et al., 2022).

These multidimensional challenges demonstrate that patchouli agribusiness sustainability cannot be assessed solely through economic indicators. A more comprehensive approach is needed to evaluate sustainability by integrating economic, social, and environmental dimensions. The Triple Bottom Line (TBL) framework provides an appropriate analytical perspective because it emphasizes the balance between economic prosperity, social well-being, and environmental responsibility. Through this framework, sustainability performance can be evaluated holistically, allowing the identification of critical strengths and weaknesses within the agribusiness system.

In addition to sustainability assessment, identifying potential risks and opportunities is essential for developing effective intervention strategies. Risk mapping helps identify factors that may threaten agribusiness sustainability, while opportunity mapping highlights potential drivers that can enhance competitiveness and development. Such information provides a valuable foundation for strategic planning and decision-making. Furthermore, SWOT analysis offers a systematic approach for integrating internal and external factors to formulate adaptive and context-specific development strategies.

Although previous studies have examined patchouli production, marketing, competitiveness, and value chain development, research integrating sustainability assessment based on the Triple Bottom Line framework with risk-opportunity mapping and strategic analysis remains limited, particularly in Polewali Mandar Regency. Consequently, comprehensive information regarding the sustainability status of the local patchouli agribusiness system and the factors influencing its future development is still lacking. Therefore, this study aims to analyze the sustainability level of patchouli agribusiness using the Triple Bottom Line framework, identify sustainability-related risks and opportunities, and formulate development strategies through SWOT analysis. The findings are expected to

provide an evidence-based foundation for policymakers, agribusiness actors, and other stakeholders in promoting a more competitive, resilient, and sustainable patchouli agribusiness system in Polewali Mandar Regency and other patchouli-producing regions of Indonesia.

2. THEORETICAL FRAMEWORK

Patchouli Agribusiness

Agribusiness is a system comprising a series of interrelated activities, ranging from the provision of production inputs, cultivation, processing, and marketing to supporting activities that enable agricultural commodities to generate economic value for business actors (The 2020 Curriculum of the Undergraduate Agribusiness Program, FEM, IPB University Page, 2020). In the context of patchouli, the agribusiness system extends beyond crop cultivation to include the distillation of patchouli leaves into essential oil, trading activities, and interactions among farmers, distillers, traders, government institutions, and market actors.

Patchouli (**Pogostemon cablin** Benth.) is an aromatic plant with high economic value and considerable market potential. Patchouli oil is widely used in the perfume, cosmetics, aromatherapy, and other natural-product industries. Its characteristic properties as a fixative in the fragrance industry have made patchouli an important commodity in Indonesia's essential oil trade (Swamy & Sinniah, 2016).

However, the patchouli agribusiness system at the smallholder level continues to face various challenges, including suboptimal productivity, limited cultivation and distillation technology, price fluctuations, restricted access to markets and capital, and weak farmer institutions. These conditions indicate that patchouli agribusiness development needs to be viewed as an integrated system involving economic, social, and environmental dimensions.

Agribusiness Sustainability

Agribusiness sustainability refers to the ability of an agricultural business system to maintain economic viability, provide benefits to society, and preserve natural resources over the long term. This concept emphasizes that agribusiness should not focus solely on short-term economic returns but also consider the social and environmental consequences of agricultural production and processing activities.

In sustainable agricultural development, the economic, social, and environmental dimensions are closely interconnected. The economic dimension concerns the ability of an enterprise to generate income, use resources efficiently, maintain competitiveness, and sustain its operations. The social dimension relates to the welfare of business actors, human resource capacity, institutions, participation, and relationships among actors within the agribusiness

system. Meanwhile, the environmental dimension involves the efficient use of natural resources, soil and water conservation, responsible use of production inputs, and the management of waste and environmental impacts (Rivai & Anugrah, 2016).

Sustainability is particularly important in agribusiness because agricultural activities are highly dependent on natural resources and the socioeconomic conditions of rural communities. Production strategies focused solely on increasing output may result in excessive input use, resource degradation, environmental pollution, or unequal distribution of benefits when they are not accompanied by appropriate management. Therefore, sustainability requires a balance between economic objectives, environmental protection, and social well-being.

In the patchouli agribusiness system, sustainability encompasses the ability of the system to generate adequate income for farmers and other business actors, maintain institutional and business relationships among actors, and preserve the resources used in cultivation and distillation. The economic dimension may include income, production costs, prices, market access, and access to capital. The social dimension may include farmer institutions, cooperation, farmer capacity, access to information, and stakeholder participation. The environmental dimension includes the use of fertilizers and pesticides, land management, and the management of distillation waste.

Therefore, agribusiness sustainability needs to be assessed from a multidimensional perspective to provide a comprehensive understanding of the condition of the system. An assessment based solely on economic indicators cannot adequately determine whether an agribusiness system can remain viable in the long term. Integrating economic, social, and environmental dimensions is necessary to identify the strengths and weaknesses of the system and determine areas requiring intervention.

The Triple Bottom Line (TBL) approach provides a relevant framework for such an assessment. TBL views sustainability through three main dimensions: **profit** as the economic dimension, **people** as the social dimension, and **planet** as the environmental dimension (Slaper & Hall, 2011). In this study, the TBL approach is used to assess the sustainability of the patchouli agribusiness system and to provide a basis for identifying the risks and opportunities that influence its sustainability.

Triple Bottom Line

The Triple Bottom Line (TBL) is a sustainability framework that evaluates business performance through three main dimensions: economic (**profit**), social (**people**), and environmental (**planet**) performance (Slaper & Hall, 2011). This approach emphasizes that the success of a business system is determined not only by its ability to generate profits but

also by the benefits it provides to society and its capacity to protect environmental sustainability.

In the patchouli agribusiness system, the economic dimension includes income, production costs, market access, and business continuity; the social dimension includes farmer institutions, cooperation, farmer capacity, and welfare; while the environmental dimension includes input use, resource conditions, and waste management. Integrating these three dimensions enables a more comprehensive assessment of patchouli agribusiness sustainability.

Risk in the Agribusiness System

Agribusiness risk refers to the possibility of conditions occurring that may disrupt expected outcomes and business continuity. Risks may arise at various stages of the agribusiness system, including production, processing, marketing, and financing. In patchouli production, risks may be associated with limited knowledge and application of Good Agricultural Practices (GAP), inadequate crop maintenance, and crop failure (Zikri et al., 2023). In addition, price fluctuations, limited access to capital, and restricted market access may affect farmers' income and business resilience.

In this study, risk is assessed based on the level of impact and probability of occurrence, so that factors with the greatest combined impact and likelihood can be prioritized for mitigation. Risk mapping is used to identify the factors posing the greatest threats to the sustainability of the patchouli agribusiness system and to provide a basis for strategy formulation.

Opportunities for Patchouli Agribusiness Development

Agribusiness development opportunities refer to external conditions or factors that can be utilized to improve productivity, competitiveness, value addition, and business sustainability. In patchouli agribusiness, such opportunities include strengthening farmer institutions, government support, technology adoption, growing market demand, and the development of derivative products. Strong farmer institutions can improve farmers' access to information, technology, financing, and markets while strengthening their bargaining position within the agribusiness chain (Anantanyu, 2011).

Technology adoption also has the potential to improve efficiency, productivity, and agricultural sustainability, although smallholder farmers may still face constraints related to infrastructure, technical capacity, and institutional support. In addition, market demand for patchouli oil and the potential development of derivative products provide opportunities to increase value added. Therefore, opportunity mapping is important for identifying the external factors with the greatest potential to support sustainable patchouli agribusiness development.

SWOT Analysis

SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis is a strategic analytical tool used to identify internal factors, namely strengths and weaknesses, and external factors, namely opportunities and threats, as a basis for strategy formulation (Pickton & Wright, 1998). SWOT connects internal conditions with the external environment, enabling the development of strategic alternatives that are more responsive to the characteristics of a particular system. Its application remains relevant as a framework for strategy formulation when the identified factors are supported by adequate information and evidence (Lohrke et al., 2022).

In this study, SWOT analysis is used to integrate the findings of the TBL sustainability assessment and the mapping of risks and opportunities in the patchouli agribusiness system. The integrated findings are subsequently used to formulate SO, WO, ST, and WT strategies to support sustainable patchouli agribusiness development.

3. RESEARCH METHODS

This study was conducted in Patambanua Village, Bulo District, Polewali Mandar Regency, West Sulawesi Province, over a one-year period. The location was selected purposively as a center for patchouli agribusiness development. A total of 100 respondents were selected using purposive sampling based on their relevance to and involvement in patchouli agribusiness, comprising: patchouli farmers (active producers, minimum 3 years of experience), distillers (directly involved in distillation), traders/collectors (involved in patchouli oil distribution), and stakeholders (involved in development policies or programs).

Data were collected through structured questionnaires based on TBL indicators to measure economic, social, and environmental dimensions; semi-structured interviews to explore risks and opportunities; and field observations. A mixed methods approach with a sequential explanatory design was employed. Three analytical stages were applied: (1) Sustainability Index Analysis constructing a sustainability index using expert judgment weighting with a Likert scale for each TBL dimension, resulting in categorized sustainability values (low, moderate, high); (2) Risk-Opportunity Mapping identifying key factors affecting patchouli agribusiness sustainability at each value chain stage, classified by impact level (low–high) and probability of occurrence (low–high), with results presented as a risk-opportunity matrix; and (3) SWOT Analysis integrating sustainability index results and risk-opportunity mapping to formulate adaptive development strategy alternatives oriented toward local value-added enhancement.

4. RESULTS AND DISCUSSION

This section covers the data collection process, the research timeframe and location, and the data analysis results (which may be supported by illustrative tables or figures—excluding raw data and screenshots of analysis outputs). It also includes a discussion on the relationship between the findings and fundamental concepts, and/or hypothesis testing results (if applicable), as well as their alignment or conflict with previous research, accompanied by their respective interpretations. This section may also address the theoretical and practical implications of the research findings. All figures and tables used must be cited and explained within the text, and must include numbering and source references. Examples of the formatting for subheadings, sub-subheadings, sub-sub-subheadings, and so forth, are provided below.

Sustainability of Patchouli Agribusiness System Based on Triple Bottom Line

Sustainability analysis of the patchouli agribusiness system was conducted using the Triple Bottom Line (TBL) approach, a strategic framework integrating the three main pillars of sustainability people, planet, and profit to comprehensively assess the performance of a business system (Slaper & Hall, 2011). TBL is regarded as the core of sustainability because it measures the impact of an organization or business system not only in terms of profitability, but also on society and the environment simultaneously (Pranesti 2019). The results of data processing show that the average sustainability values for each dimension are as follows:

Table 1. Average Sustainability of Economic, Social, and Environmental Dimensions in Patambanua Village, Bulo District, Polewali Mandar Regency, 2026.

No	Dimension	Average Value	Category
1	Economic	3.44	Moderate
2	Social	3.51	Fairly Good
3	Environmental	3.38	Moderate
4	TBL Index	3.44	Moderate

Source: Primary Data Processed, 2026

Based on Table 1, the social dimension achieved the highest score (3.51), while the environmental dimension scored the lowest (3.38). Overall, the TBL sustainability index of the patchouli agribusiness system reached 3.44, indicating a moderate sustainability category. This finding is consistent with research on TBL-based sustainable agriculture showing that agribusiness systems in Indonesia generally still face challenges in optimally integrating all three sustainability dimensions, particularly in the environmental aspect (Rivai & Anugrah, 2016; Sulaksana & Triana, 2025; Wahyudi et al., 2025). The results indicate that the patchouli agribusiness system has been able to provide economic and social benefits to the community,

but still faces significant environmental challenges requiring serious attention (Irmawati, 2025).

Economic Dimension

The economic dimension scored an average of 3.44, placing it in the moderately sustainable category. This reflects the patchouli agribusiness system's capacity to generate income for farming households, supported by relatively stable market demand. Indonesia's strategic position as the world's largest patchouli oil producer with a Revealed Comparative Advantage (RCA) value of 4,129 for the Singapore market and 3,526 for France underscores its strong comparative advantage in international trade (Adiwijaya & Salqaura, 2025). According to the Central Statistics Agency, the value of Indonesian essential oil exports in 2023 reached approximately USD 139.15 million, with patchouli oil as a major contributor (Statistik, 2023). However, sustainability is constrained by price volatility and rising production costs, causing income instability for farmers (Asriani et al. 2025; Irmawati, Irmayanti 2025).

Social Dimension

The social dimension achieved the highest score (3.51), reflecting well functioning relationships among agribusiness actors, farmer cooperation, farmer group presence, and accumulated cultivation experience. Farmer institutional capacity plays a central role in strengthening the social dimension. As (Anantanyu, 2011) notes, strong institutional capacity enhances farmer bargaining power and creates income equity across the agribusiness subsystem chain. Effective institutions facilitate training, aid distribution, financial access, and cooperative development, enabling collective marketing to improve efficiency and productivity (Akbar et al., 2022). However, in Patambanua Village, price determination is still dominated by collectors or distillery owners, indicating that institutional functions have yet to be fully realized.

Environmental Dimension

The environmental dimension scored the lowest (3.38), indicating that environmental management practices need improvement. Key issues include suboptimal distillation waste management, excessive chemical fertilizer use, and potential land degradation from intensive land use. Globally, over 33% of the world's land has been degraded, with productivity declining by 25 – 40%; in Indonesia, degraded land covers 24.3 – 48.3 million hectares, especially in upland areas (KLHK 2022; Wulandari and Astiko 2025). Farmers in Patambanua Village have not yet adopted environmentally friendly cultivation practices. Sustainable land management

approaches including agroforestry, crop rotation, soil and water conservation, and organic fertilizer use are proven to restore degraded land productivity (Lehmann et al., 2020).

Risk Mapping of Patchouli Agribusiness Sustainability

Risk analysis was conducted by measuring the impact level and probability of each factor affecting patchouli agribusiness sustainability. The risk score is obtained by multiplying the impact value by the probability value; the higher the score, the greater the risk level. Table 2 presents the results of the sustainability risk mapping.

Table 2. Sustainability Risk of Patchouli Agribusiness in Patambanua Village, Bulu District, Polewali Mandar Regency, 2026.

No	Risk Factor	Score	Category
1	Limited market access	17.52	High
2	High production costs	17.47	High
3	Labor shortage	17.35	High
4	Distillation waste	17.31	High
5	Chemical fertilizer use	16.71	High
6	Price fluctuation	15.74	High
7	Limited capital access	15.49	High
8	Pest and disease attacks	14.89	Moderate
9	Extreme weather	13.20	Moderate
10	Land degradation	10.28	Moderate
11	Low youth participation	7.81	Low

Source: Primary Data Processed, 2026

Based on Table 2, the highest-risk factor is limited market access (17.52). This indicates that marketing access remains the main constraint in patchouli agribusiness development. Limited market access causes low farmer bargaining power and dependence on collectors, reducing business profitability. As shown by (Qomariah et al. 2023), farmers' inability to deal directly with factories or exporters forces them to depend on marketing intermediaries, resulting in significant price differentials between farm gate and export prices. This is further exacerbated by the oligopolistic structure of the patchouli oil market, where a few dominant actors control trade (Adiwijaya & Salqaura, 2025).

High production costs (17.47) and labor shortage (17.35) are the next highest risks. Rising production costs reduce business efficiency and pressure farmer income, while labor shortages driven by urbanization and the low attractiveness of agriculture for young people hamper cultivation, maintenance, and post-harvest activities (Mustakin, 2018; Paulina et al., 2024). These two factors are interrelated, as addressing labor shortages often requires additional costs that further raise total production costs.

On the environmental side, distillation waste (17.31) and chemical fertilizer use (16.71) are classified as high-risk. If not managed properly, distillation waste biomass when directly discharged without treatment can contaminate soil and water sources and disrupt agricultural ecosystem balance (Iswanto et al., 2023; Jasmani et al., 2023). Continuous use of chemical fertilizers, as practiced by farmers in Patambanua who believe more fertilizer improves plant growth, is recognized as damaging to soil quality in the long term (KLHK 2022). Furthermore, price fluctuation (15.74) and limited capital access (15.49) belong to the high-risk category, potentially affecting farmer capacity to develop businesses and maintain income stability (Asriani et al., 2025; Zikri et al., 2023). Pest and disease attacks, extreme weather, and land degradation fall in the moderate-risk category, while low youth participation (7.81) represents a low-risk factor, yet remains important for long-term sustainability given the need for farming regeneration.

Opportunity Mapping of Patchouli Agribusiness Sustainability

Opportunity analysis was conducted to identify positive factors that can be leveraged to support patchouli agribusiness sustainability. Table 3 presents the sustainability opportunity mapping results.

Table 3. Sustainability Opportunities of Patchouli Agribusiness in Patambanua Village, Bulo District, Polewali Mandar Regency, 2026.

No	Opportunity Factor	Score	Category
1	Farmer institutions	17.22	High
2	Government support	16.94	High
3	New technology	16.91	High
4	High export demand	13.15	Moderate
5	Derivative products	8.15	Low

Source: Primary Data Processed, 2026

The greatest opportunity lies in farmer institutional strengthening (17.22). Strong farmer institutions are important social capital in patchouli agribusiness development, as they enable farmers to improve bargaining power, expand information access, and optimize produce marketing. As (Anantanyu, 2011) notes, institutional strengthening is the entry point for activating rural agribusiness systems. Active institutions that facilitate training, aid distribution, and cooperative development have been proven to significantly improve agribusiness efficiency and productivity (Akbar et al., 2024; Haryanto et al., 2023).

Government support (16.94) is the second-highest opportunity. Support through training programs, extension services, production facility assistance, and farmer capacity strengthening can serve as a driver for improving patchouli agribusiness productivity and competitiveness. New technology adoption (16.91) also represents a major opportunity, as modern cultivation and distillation technology can enhance production efficiency, patchouli oil quality, and farmer value-added. High export demand (13.15) falls in the moderate opportunity category, reflecting the good prospects of export markets while acknowledging the risk of global demand fluctuations. Meanwhile, derivative products (8.15) are a low-opportunity factor, yet retain potential for business diversification; research by (Swamy & Sinniah, 2016) shows that patchouli extracts effectively inhibit the growth of pathogenic bacteria, opening opportunities in the pharmaceutical and health industries. Indonesia's strong export competitiveness with RCA values consistently above 1 confirms its dominant position as a specialized patchouli exporter in the global market (Adiwijaya & Salqaura, 2025).

Integration of Sustainability Risk and Opportunities

The mapping shows that the social dimension is the strongest in the patchouli agribusiness system, marked by the highest TBL sustainability score (3.51) and strong farmer institutions. This is consistent with the finding that social cohesiveness among farmers and strong institutions are fundamental social capital for sustainable agribusiness development in Indonesia (Anantanyu, 2011). Conversely, the environmental dimension is the most vulnerable, given the high risks of distillation waste (17.31), chemical fertilizer use (16.71), and land degradation (10.28) consistent with the general challenge of plantation-based agribusiness systems in Indonesia to consistently implement environmentally friendly production practices (KLHK, 2022). In the economic dimension, sustainability is influenced by high market risk, price fluctuation, and capital access limitations, yet opportunities exist in strong export demand and government programs. Therefore, sustainable patchouli agribusiness development strategies must focus on reducing environmental and economic risks by leveraging institutional, technological, and government support opportunities.

SWOT Analysis of Sustainable Patchouli Agribusiness Development

SWOT analysis was used to identify internal and external factors affecting sustainable patchouli agribusiness development in Patambanua Village. Internal factors include strengths and weaknesses, while external factors include opportunities and threats. SWOT identification was based on TBL analysis results and the risk-opportunity mapping.

Strengths

Strength factors represent the internal advantages that support the sustainability of patchouli agribusiness in Patambanua Village. The identified strength factors and their respective scores are presented in Table 4.

Table 4. Strengths in Patchouli Agribusiness Sustainability, Patambanua Village, Bulu District, Polewali Mandar Regency, 2026.

No	Code	Strength Factor	Score
1	S1	Strong farmer institutional opportunity	(17.22)
2	S2	Highest TBL score in social dimension	(3.51)
3	S3	Available government support	(16.94)
4	S4	New technology adoption opportunity	(16.91)
5	S5	Farmer experience in cultivation and distillation	-

Source: Primary Data Processed, 2026

Weaknesses

Despite having several strengths, the patchouli agribusiness system also faces a number of internal weaknesses that may hinder its sustainability and development. The identified weakness factors are presented in Table 5.

Table 5. Weaknesses in Patchouli Agribusiness Sustainability, Patambanua Village, Bulu District, Polewali Mandar Regency, 2026.

No	Code	Weakness Factor	Score
1	W1	High production costs	(17.47)
2	W2	Limited capital access	(15.49)
3	W3	Labor shortage	(17.35)
4	W4	Suboptimal distillation waste management	(17.31)
5	W5	Excessive chemical fertilizer use	(16.71)

Source: Primary Data Processed, 2026

Opportunities

Opportunity factors reflect external conditions that can be utilized to enhance the sustainability and competitiveness of patchouli agribusiness. The identified opportunity factors are presented in Table 6.

Table 6. Opportunities in Patchouli Agribusiness Sustainability, 2026.

No	Code	Opportunity Factor
1	O1	Farmer institutions can be further strengthened
2	O2	Government support for patchouli commodity
3	O3	New technology adoption

No	Code	Opportunity Factor
4	O4	High export demand for patchouli oil
5	O5	Development of patchouli derivative products

Source: Primary Data Processed, 2026

Threats

In addition to opportunities, patchouli agribusiness is also exposed to various external threats that may affect its long-term sustainability. The identified threat factors are presented in Table 7.

Table 7. Threats in Patchouli Agribusiness Sustainability, 2026.

No	Code	Threat Factor	Score
1	T1	Limited market access	(17.52)
2	T2	Price fluctuation	(15.74)
3	T3	Pest and disease attacks	(14.89)
4	T4	Extreme weather	(13.20)
5	T5	Land degradation	(10.28)

Source: Primary Data Processed, 2026

Matriks SWOT

Based on the identified internal and external factors, a SWOT matrix was developed to formulate strategic alternatives for sustainable patchouli agribusiness development. The resulting SWOT matrix is presented in Table 8.

Table 8. SWOT Matrix of Sustainable Patchouli Agribusiness Development, 2026.

Internal / External	Opportunities (O)	Threats (T)
Strengths (S)	SO Strategy: Leverage strengths to capitalize on opportunities	ST Strategy: Use strengths to face threats
Weaknesses (W)	WO Strategy: Use opportunities to overcome weaknesses	WT Strategy: Minimize weaknesses and avoid threats

Source: Primary Data Processed, 2026

The SO strategy focuses on leveraging institutional strength to access government programs, adopting modern distillation technology, capitalizing on export demand to increase production and quality, and developing derivative products to enhance value-added. Farmer institutional strengthening in response to high export market opportunities is consistent with successful strategies applied to other Indonesian plantation commodities (Hartono R et al., 2024). The WO strategy uses available opportunities to overcome weaknesses: utilizing government assistance to reduce capital and production cost constraints; applying new technology to improve labor-use efficiency; developing environmentally friendly distillation waste management training; and promoting derivative product innovation as an additional

income source. Government support utilization has proven effective in improving farmer capacity across various agribusiness sectors (Mulyana et al., 2024).

The ST strategy leverages institutional and government strengths to face threats such as price fluctuation and limited market access, while developing farmer capacity to manage climate change and pest attacks. Strengthening farmer cooperation is the key to improving collective bargaining power against price volatility (Anantanyu, 2011). The WT strategy minimizes weaknesses and avoids threats through increasing production efficiency via appropriate technology, diversifying marketing channels to reduce market access risk, implementing environmentally friendly cultivation to reduce land degradation, and improving farmer access to financing through cooperation with financial institutions. Channel diversification is particularly important given that limited market access is the highest risk factor in patchouli agribusiness.

Table 9. Priority Strategies for Sustainable Patchouli Agribusiness Development, 2026.

No	Priority	Strategy
1	1	Strengthening farmer institutions and market access
2	2	Adopting modern cultivation and distillation technology
3	3	Improving capital access and production efficiency
4	4	Sustainable distillation waste management
5	5	Developing derivative products and market diversification

Source: Primary Data Processed, 2026

The first priority strategy strengthening farmer institutions and market access is the primary foundation for sustainable patchouli agribusiness development. Strong institutions enable farmers to improve bargaining power, expand information access, and optimize produce marketing, reducing dependence on collectors (Akbar et al., 2022; Anantanyu, 2011). The second priority adopting modern cultivation and distillation technology addresses the root cause of production risks, as most patchouli agribusiness problems stem from simple management practices in site selection, cultivation, variety selection, and post-harvest handling (Zikri et al., 2023). The third priority focuses on improving capital access and production efficiency. Limited capital is a major barrier to patchouli agribusiness development, requiring collaboration among government, financial institutions, and farmer groups to expand agricultural financing access. The fourth priority sustainable distillation waste management aligns with circular economy principles; patchouli distillation waste biomass can be processed into organic fertilizer or renewable energy, reducing environmental impact while improving business efficiency (Iswanto et al., 2023; Sara et al., 2021). The fifth priority developing derivative products and market diversification leverages the strong biological activity of

patchouli active compounds across perfume, cosmetics, pharmaceutical, and aromatherapy industries (Swamy & Sinniah, 2016), while reducing dependence on a single market segment.

5. CONCLUSION

The sustainability analysis using the Triple Bottom Line framework shows that the patchouli agribusiness system in Patambanua Village, Bulu District, Polewali Mandar Regency achieved a TBL sustainability index of 3.44, categorized as moderate. The social dimension scored highest (3.51) driven by active farmer group cooperation and long-standing cultivation experience, while the environmental dimension scored lowest (3.38) due to suboptimal distillation waste management and excessive chemical fertilizer use. Risk mapping identified seven high-risk factors with limited market access as the critical risk (score 17.52), followed by high production costs and labor shortage. Opportunity mapping revealed that farmer institutional strengthening represents the greatest strategic opportunity (17.22), supported by government program availability and new technology adoption. SWOT analysis produced five priority strategies: (1) strengthening farmer institutions and market access, (2) adopting modern cultivation and distillation technology, (3) improving capital access and production efficiency, (4) sustainable distillation waste management, and (5) developing derivative products and market diversification. These findings provide an evidence-based foundation for policymakers and agricultural stakeholders to formulate more targeted, adaptive, and sustainability-oriented patchouli agribusiness development programs in Polewali Mandar Regency.

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