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Development of African Night Crawler (*Eudrilus eugeniae*) Agribusiness: Opportunities, Challenges, and Strategies

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Abstract: This study, conducted at CV Rumah Alam Jaya in Malang, East Java, Indonesia, aims to explore the potential and challenges of African Night Crawler (ANC) earthworm agribusiness and to formulate sustainable development strategies. Using a mixed-methods case study approach, data were collected through focus group discussions (FGDs), semi-structured interviews, and structured questionnaires (quantitative Likert-scale). Ten FGD participants included worm farmers, extension agents, agribusiness practitioners, and local government officials selected based on their direct involvement in worm agribusiness activities. SWOT factors were identified through thematic analysis of qualitative data, while weights and ratings were derived from FGDs and expert interviews. The analysis places ANC agribusiness in the Growth/Expansion quadrant, supported by easy-to-apply cultivation techniques, strong market potential, and availability of low-cost organic feed. However, it faces internal weaknesses (such as pest vulnerability, limited consumer awareness) and external threats (such as market competition, regulatory constraints). Based on these findings, four integrated strategies are proposed: (1) implementing IoT-based moisture and temperature monitoring, (2) adopting multi-tier rack systems to optimize space use, (3) expanding market access via digital platforms such as Shopee and Tokopedia, and (4) strengthening institutional collaboration and farmer training to improve business sustainability and resilience.

Keywords: Agribusiness; ANC earthworm; Strategy; Sustainability

Introduction

Eudrilus eugeniae, commonly known as the African Night Crawler (ANC), is a species of earthworm that has gained increasing attention due to its multifunctional roles across several agribusiness sectors. In agriculture, ANC is valued for its ability to produce "vermicast", a nutrient-rich organic fertilizer that enhances soil fertility and supports sustainable cultivation practices (Blakemore, 2015; Tyagi et al., 2023). In aquaculture, it serves as a high-protein natural feed for fish and shrimp (Steckley, 2022). Meanwhile, in the pharmaceutical sector, ANC and other earthworm species are utilized as sources of bioactive compounds such as the lumbrokinase enzyme, which shows promise for cardiovascular therapy (Wang et al., 2019). While lumbrokinase is not specific to ANC, the increasing commercial interest in earthworm-based products underscores the species' broader economic potential.

In Indonesia, the cultivation of ANC has experienced notable growth, driven by heightened awareness of sustainable agriculture, the demand for organic inputs, and emerging markets for environmentally friendly products. ANC agribusiness not only supports organic waste management and soil health but also offers economic benefits through the sale of vermicast, biomass, and derivative products. Previous studies have emphasized the untapped market potential

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of organic inputs derived from earthworms, particularly in regions where ecological agriculture is growing (Plaas et al., 2019). However, realizing this potential requires more than just technical know-how. Farmers and agribusiness actors face challenges in production efficiency, disease and pest control, product marketing, price fluctuations, and limited access to formal markets (Zarafshani et al., 2015). The expansion of sustainable agribusiness sectors, such as vermiculture, requires not only technological innovation but also an enabling institutional environment to ensure scalability and resilience (Argyroudis et al., 2022).

Despite these constraints, successful ANC-based agribusinesses do exist. For example, CV Rumah Alam Jaya has developed innovative practices in ANC agribusiness and marketing. However, such cases are still limited and often not widely replicated due to a lack of integrated business models and strategic guidance.

This research is important because it responds to the gap between ANC's biological potential and its underutilization as a sustainable agribusiness commodity. While previous studies have concentrated on the biological and ecological aspects of ANC (Baylon & Catian, 2019; Kabi et al., 2018; Macabuhay et al., 2016; Ponsen et al., 2023), this study introduces a comprehensive approach that bridges technical production with commercial, economic, and strategic dimensions.

The novelty of this research lies in the integration of ANC agribusiness into a sustainable agribusiness model that is not only ecologically sound but also economically viable. This is in line with efforts to enhance agribusiness sustainability through community empowerment models that emphasize independence and local resource optimization (Suranto & Pratiwi, 2023). Formulating development strategies that are grounded in the availability of local inputs and ecosystem integration has proven effective in increasing productivity and farmer independence (Sholikin et al., 2024). By analyzing the full value chain—from input management and production challenges to market access and business development strategies—this research offers a holistic framework for scaling up ANC agribusiness in Indonesia. It contributes practical insights for stakeholders seeking to build resilient, profitable, and environmentally responsible agribusiness ventures based on ANC.

Method

This study employs a mixed methods case study research design, combining both quantitative and qualitative approaches to obtain a comprehensive understanding of the business dynamics and development strategies of African Night Crawler (ANC) agribusiness. Mixed-methods research designs are particularly useful for complex agribusiness systems, as they allow for triangulation between qualitative insights and quantitative indicators (Strijker et al., 2020). The case study focuses on CV Rumah Alam Jaya, a business engaged in the cultivation and marketing of *Eudrilus eugeniae* and its derivative products.

The research was conducted at CV Rumah Alam Jaya in Malang Regency. The site was purposively selected due to its relevance to the research objectives and the accessibility of in-depth information. Research subjects included: the business owner (key decision-maker), 11 employees involved in production and operational processes, 15 business partners (raw material suppliers and product distributors), 30 randomly selected consumers of ANC products, and agricultural experts and policymakers, including academics, extension agents, and representatives from the Department of Agriculture, certification bodies, and trade regulators.

To enhance validity and triangulation, five data collection methods were used. Firstly, in-depth interviews with business owners, employees, experts, and policymakers to explore business strategies, operational challenges, innovation adoption, and regulatory issues. According to Febrianti et al. (2024), Socio-economic characteristics such as education, age, and farming experience significantly influence the adoption of sustainable agricultural innovations. Secondly, direct observation of cultivation processes, media management, and marketing activities. Thirdly, document analysis involving historical business data, including production volume, financial reports, and marketing records. Next, structured questionnaires distributed to business partners and consumers to assess satisfaction, product preferences, market trends, and partnership challenges. Last data collection method was Focus Group Discussions (FGDs). The combination of focus group discussions with expert interviews enhances the robustness of participatory strategy formulation, especially when exploring agribusiness interventions at the grassroots level (Tekle et al., 2024). FGDs were also conducted involving 8 participants, including the business owner, employees, experts, and policymakers. The discussions focused on identifying internal and external factors affecting ANC agribusiness and validating SWOT elements.

Quantitative analysis was used to evaluate numerical data such as production trends, consumer responses (Likert scale-based satisfaction levels), and market growth patterns. Qualitative data from interviews, FGDs, and observations were analyzed using thematic analysis, identifying recurring patterns and themes related to business challenges, innovation potential, and stakeholder perceptions. SWOT Analysis was employed to categorize internal (Strengths and Weaknesses) and external (Opportunities and Threats) factors based on both qualitative insights and quantitative indicators.

The integration was carried out during the interpretation stage: a) Quantitative findings (e.g., production growth, consumer satisfaction) were used to support or challenge insights obtained from qualitative themes (e.g., operational constraints, marketing strategies). b) The combined results informed the formulation of strategic recommendations for sustainable ANC agribusiness development. c) The FGD results served as a validation mechanism to reconcile findings from both data types and finalize strategic priorities.

The following flowchart illustrates the mixed methods case study research design employed in this study, detailing the sequential stages (from research site selection, data collection, and analysis to the integration of findings and strategy formulation).

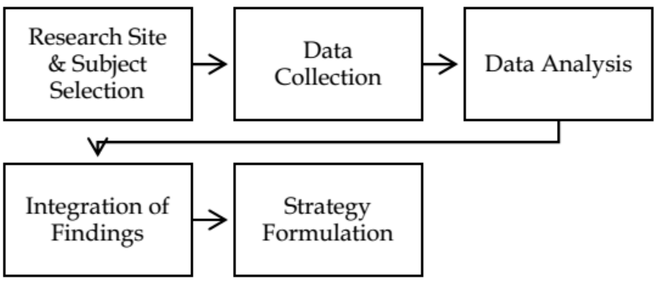

Figure 1. Research flowchart

Result and Discussion

This section presents the results of the research and provides a comprehensive discussion regarding the business profile, cultivation methods, and strategic planning of CV Rumah Alam Jaya (RAJ). It begins by outlining the company's growth trajectory and operational scale, followed by an analysis of agribusiness opportunities in ANC (African Nightcrawler) earthworm cultivation. Furthermore, a SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis is conducted using a structured and participatory approach. The SWOT weights were assigned through Focus Group Discussions (FGDs) involving key stakeholders, while ratings were obtained from semi-structured interviews with selected experts in agribusiness and vermiculture.

To ensure the validity of the SWOT analysis, the weighting of internal (strengths and weaknesses) and external (opportunities and threats) factors was conducted through a structured Focus Group Discussion (FGD) and expert judgment method. The FGD included 10 participants representing key stakeholders: CV RAJ's management team, senior operational staff, and long-term business partners. Each factor's weight was determined using a consensus-building process based on its perceived importance to the firm's strategic performance, on a scale of 0.0 (not important) to 1.0 (very important), ensuring that total weights for each category (IFAS and EFAS) sum to 1.0.

Ratings were collected through semi-structured interviews with 6 experts, including 2 agricultural economists, 2 agribusiness practitioners, and 2 academics with experience in sustainability and agricultural innovation. Each expert assigned scores from 1 (major weakness/threat) to 4 (major strength/opportunity) for each factor. The final rating for each factor represents the average of all expert responses.

Recognizing the inherent subjectivity in assigning weights and ratings, steps were taken to reduce bias. The Delphi technique was partially implemented by allowing experts to review and revise their ratings after seeing anonymized responses from other participants. Furthermore, triangulation between FGDs and expert interviews helped to validate the consistency of identified factors. Disagreements were resolved through moderated discussion sessions to reach collective agreement, ensuring the robustness of the resulting SWOT matrix.

Business Profile of CV Rumah Alam Jaya (RAJ)

CV Rumah Alam Jaya (RAJ) is a business engaged in the cultivation and agribusiness of earthworms, specifically the *Eudrilus eugeniae* species. Founded by Abdul Aziz Adam Maulid, the business has experienced rapid growth since 2012, with a strong commitment to developing the earthworm industry from upstream to downstream. Located at Jl. S. Supriyadi Gg 9 No. 42, Malang City, East Java, CV RAJ has obtained a Business Identification Number (NIB) since 2022, signifying its legal status and readiness to operate on a larger scale.

With the vision of "Developing the Upstream-Downstream Earthworm Industry," CV RAJ focuses on the production, processing, and marketing of earthworms and their derivative products. Since its inception, the business has grown from a small-scale operation to a large-scale production enterprise. In 2012, cultivation was conducted on 10 plots, each measuring 0.2 m^2, producing 2 kg of earthworms every two weeks. Through effective expansion strategies, the number of plots increased to 2,400, covering an area of 12,000 m^2 by 2023, yielding 1,200 kg of earthworms every two weeks.

In its operations, CV RAJ collaborates with 200 partner seed suppliers and is supported by 11 permanent employees. With a production cycle running every two weeks, CV RAJ is capable of harvesting twice a month, yielding an average of 1,200 kg per cycle. In addition to fresh earthworms, the business has developed eight types of derivative products, including vermicast (organic fertilizer), worm meal, and various processed products marketed in Malang and surrounding areas. Building on over 11 years of experience, CV Rumah Alam Jaya has consistently introduced innovations in both cultivation and business operations. Through production efficiency and market expansion, CV RAJ aims to become a leading player in the sustainable and high-value earthworm cultivation industry.

Table 1. Business Scale Development of CV RAJ (Primary Research Data, 2024)

Year	Number of Plots (Plot Area)	Earthworm (kg)	Production (kg/ 2 Weeks)
2012	10 Plots (0,2m^2)	10	2
2020	400 Plots (2000m^2)	1.000	200
2021	400 Plots (2000m^2)	1.000	200
2022	2000 Plots (10.000m^2)	5.000	1000
2023	2400 Plots (12.000m^2)	6.000	1.200

Agribusiness Opportunities in ANC Earthworm

ANC Earthworm Cultivation and its Applications

ANC earthworm cultivation is relatively easy and can be applied by various groups, from household-scale operations to commercial enterprises. Different cultivation methods, such as the flatbed system, ridge system, worm apartments, wooden rack systems, and plastic bucket systems, offer flexibility for farmers to choose the most suitable approach based on their capacity and environmental conditions. Each system has its own advantages, ranging from land efficiency to optimized production management, as described below.

The ease of ANC worm cultivation lies in the availability of cheap and easily accessible raw materials, such as animal manure, sawdust, agricultural waste, and other organic materials. With a simple maintenance system, farmers can efficiently manage worms through routine care, including watering, media loosening, and organic feed management. Worm feed consists of organic materials. Organic material sources can be obtained from the surrounding environment by utilizing various waste products from daily human activities. These materials include kitchen waste, market waste, banana peels, coconut pulp, tofu dregs, rice bran, stale bread, and other organic waste (Le et al., 2020). It is recommended that worm feed be decomposed or fermented for 1-3 days using molasses and decomposing bacteria. The purpose of fermentation is to soften the organic material so that it is easily absorbed by worms and to eliminate pathogenic bacteria and fungi that could disrupt worm life. The amount of feed given gradually increases from the start of cultivation to the end, adjusting to the worms' size and weight.

Table 2. Comparison of ANC Cultivation Methods (Primary Research Data, 2024)

Cultivation Methods	Advantages	Disadvantages
<u>Flatbed System:</u> Cultivation is carried out in a brick or lightweight brick basin with a soil, cement, or paving base. The medium consists of aged cow manure with a thickness of 5-10 cm.	-Low initial cost -Easy to apply in various locations -Suitable for large-scale cultivation	-Vulnerable to extreme weather -More difficult moisture management
<u>Ridge System:</u> Cultivation is done on soil ridges measuring 1x8 m with a height of 15-20 cm. Paranet or mesh is used as protection.	-More optimal in maintaining media aeration -Higher production compared to the flatbed system	-Requires large land area -Managing ridges requires more labor
<u>Worm Apartment System</u>: Multi-tiered cultivation in boxes measuring 50x60 cm with a height of 10-15 cm. The medium consists of mushroom logs, cocopeat, or tapioca waste.	-Space-saving, suitable for limited land -More controlled and hygienic production	-Higher initial cost -More intensive maintenance
<u>Wooden Rack System:</u> Uses multi-tiered wooden racks (1x3 m, height 12 cm), with five layers per rack. The medium consists of leftover mushroom logs or cocopeat.	-Maximizes vertical space -Easier worm harvesting	-Relatively high construction costs -Susceptible to excessive moisture, which can damage wood
<u>Plastic Bucket System:</u> Cultivation in 40 cm diameter buckets with holes at the bottom. The medium consists of mushroom logs (Dini et al., 2024), cocopeat, or rice bran.	-Suitable for household-scale cultivation -Easy to move and control	-Limited production capacity -Requires frequent maintenance

Proper initial media preparation is essential for successful worm cultivation. The initial media must be moist, loose, and consist of a mixture of more than one type of material. If animal manure is used, it should be at least seven days old. The initial media thickness should be around 5-8 cm. Before the worms are introduced, the cultivation container or bed should be adequately watered. Media can be spread before or after introducing the worm breeders.

Worm breeders are introduced at a stocking density of 2.5 kg/m^3. The worms should be evenly distributed across the cultivation area. After introduction, it is necessary to wait for 30 minutes—if the worms enter the media, it means the conditions are suitable. However, if they do not burrow into the media, adjustments are needed by adding materials with better moisture and porosity. The reasons for worms not entering the media could be that it is too dry or too wet, fermentation is incomplete, or the manure is too fresh. To address these issues, initial adjustments must be made before stocking.

Worm feeding can be done using two methods: wet feeding and dry feeding. Wet feeding allows worms to absorb nutrients, while dry feeding allows them to ingest the feed directly. Both methods involve scattering the feed on the surface, with feeding amounts starting at 5-10% per day of the juvenile worm population and increasing to 50-100% per day for the adult worm population. Feeding is done every 2-3 days.

Watering the media is crucial for maintaining moisture. The frequency depends on field conditions and needs. Various water sources can be used, but fishpond water (e.g., from catfish or tilapia ponds) is preferred. Watering should be done just enough to maintain moisture without making the media too wet, as excess water can cause compaction.

Loosening the media is done by turning it over. The purpose is to stimulate worm activity (movement, mating, etc.), improve air circulation, and enhance worm growth. For rack-based systems, loosening should be done every two weeks by flipping the media, while for flatbed systems, loosening should only be done on the surface (5-8 cm deep).

Vermicast (worm castings) harvesting involves removing worm waste from the media. This process is done every 1-3 months, depending on the system used. The larger the cultivation area, the longer the interval between harvests. A maximum of 25% of the media is removed from the top layer at a time. Vermicast harvesting is usually done together with the addition of new media.

Worm harvesting begins after 3-4 months of breeding. Monthly harvesting involves removing a maximum of 50% of the worm population, primarily from the media edges where mature worms tend to gather. Worms are separated from the media manually using brushes, with 2-3 repetitions for thorough separation. For large-scale harvesting, a reservoir system can be used, where worms are maintained until they reach the target weight. The maximum storage time in this system is seven days. Worms are typically weighed in batches of 5 kg. To prevent stress, 1-1.5 kg of media is added. The worms and media (2 kg total) are then packed in 40 x 70 cm bags, securely tied at the top. The fabric used should have pores large enough for air circulation but small enough to prevent worms from escaping.

Final packaging involves placing the fabric bags into wooden crates or baskets, with one bag per crate. The crates are tied on both ends to prevent movement during transport. The maximum travel time for transportation is two days; if the journey exceeds this period, backup media should be carried. The best shipping time is in the evening or at night.

Diversification of ANC Worm Cultivation Products

Product diversification efforts aim to maximize the economic potential of each stage of worm cultivation. Beyond vermicast and fresh worms, CV RAJ is developing high-protein worm meal for poultry and aquaculture, bio-stimulants from worm extract, and encapsulated fertilizer pellets for urban gardening. These initiatives aim to ensure that the entire farm production cycle contributes to multiple value-added streams, reducing waste and enhancing economic resilience.

Chaudhuri (2019) mentioned that implementation of earthworm-based technology has the potential to be a key solution for advancing a second Green Revolution. Beyond fresh worms, ANC worm cultivation has diversified into various high-value products, including vermicast, dried worms and worm meal, worm extract, and other integrated agribusiness products.

According to Kavitha (2023), earthworms have an exceptional ability to process various types of organic matter. Their digestive system contains cellulase enzymes that break down waste into valuable compost. Vermicompost serves as a highly effective fertilizer for crop cultivation and a nutrient-rich feed source. Meanwhile, dried worms and worm meal are used as raw material for livestock and fish feed due to their high protein content. Idris (2024) substituted fish meal with ANC worm meal for enhancing the physical quality of fish feed.

Worm extract utilized in the pharmaceutical and livestock industries as a health supplement and immune booster for animals (Sun et al., 2020). Moreover, combining worm cultivation with banana, papaya, and livestock cultivation to optimize agricultural ecosystem efficiency (Dissanayaka et al., 2024; Khan et al., 2020). Through innovative product diversification, ANC worm agribusiness can become a value-added sector, reducing reliance on fresh worm sales and enhancing competitiveness in the market.

Market demand for ANC worms continues to grow in the agriculture, aquaculture, and pharmaceutical sectors. Regionally, CV Rumah Alam Jaya has expanded its market reach to Malang and surrounding areas, with potential for further expansion to major cities. The advantages of worm-based products, especially vermicast and worm extract, make this sector increasingly attractive to the organic cultivation and livestock industries (Bellitürk & Sundari, 2024). On a national scale, the growing trend of organic cultivation and natural feed is driving demand for ANC worm-based products. Digital marketing and e-commerce are crucial strategies for expanding distribution reach, enabling CV RAJ to compete in broader markets. With technological support and strong business partnerships, ANC worm agribusiness can develop into a sustainable and high-value industry. In line with Amruddin (2025), agricultural modernization plays a pivotal role in improving rural livelihoods, including through worm-based ecological solutions.

Challenges in ANC Worm Cultivation

Similar to cattle farming (Rasyid et al., 2024), ANC farmers face limitations in access to financial and technological resources, which can hinder business scalability. ANC worm cultivation challenges categorized into three main aspects: technical, managerial, and marketing challenges. Technical obstacles include environmental conditions, production facilities, and feed quality. Environmental factors such as unstable temperature and humidity can affect worm productivity. Environmental fluctuations, including changes in moisture and temperature, are known to significantly affect the reproductive and metabolic activities of *Eudrilus eugeniae* (Anusha et al., 2023). Additionally, pests like ants, rats, frogs, and birds can significantly reduce worm populations. Studies by Sherman (2018) suggest that using shade nets or mesh coverings can reduce losses caused by predators. The main managerial challenges include labor management and operational efficiency. Large-scale operations require skilled workers to manage feeding, harvesting, and processing derivative products. Poor management can lead to decreased productivity and increased operational costs.

In the marketing sector, product competitiveness and consumer education remain significant challenges. Many people are still unaware of the benefits of worms and their derivative products, making market education a crucial step. Limited awareness of vermiculture benefits among consumers has been cited as a key constraint in scaling up worm-based agribusinesses (Brenya et al., 2023). Price fluctuations also pose a challenge, especially when demand is unstable. Income generation capacity is influenced by both market access and farmers' ability to diversify products (Purnama et al., 2023), which is also relevant to worm-based agribusiness. Research by Kamar-Zaman et al. (2022) indicates that digital marketing strategies and partnerships with the agricultural and aquaculture sectors can enhance the competitiveness of ANC worm-based products. Moreover, improving the professionalism of worm farmers through structured training and human capital development is essential for business sustainability (Anwar et al., 2023). Given the aforementioned constraints, strategic responses were formulated to address internal weaknesses and external threats through a structured SWOT analysis. In response to these multifaceted challenges, a strategic framework was developed to guide the sustainable advancement of ANC worm agribusiness.

Strategies for Sustainable ANC Worm Agribusiness Development

The development of ANC worm agribusiness requires a comprehensive strategy to ensure business sustainability. One approach is the SWOT analysis. As demonstrated in organic rice development, sustainable agribusiness strategies based on SWOT-AHP can help prioritize strategic actions that align with ecological, social, and economic dimensions (Muala et al., 2024). Business performance in agriculture, according to Rohani et al. (2024), is strongly influenced by internal factors like human resources and management, as well as external factors such as government support and community participation. By identifying internal factors (IF) and aligning them with external factors (EF), ANC worm cultivation can be positioned as a sustainable and competitive agribusiness sector.

Table 3. SWOT Matrix and Strategic Responses (Primary Research Data, 2024)

Internal and External Factors	Strengths (S)	Weaknesses (W)
	S1: Cultivation is easy to apply across various business scales. S2: Products have high economic value (fresh worms, worm castings, worm extract, etc.). S3: Market demand continues to increase, especially in the agricultural and livestock sectors. S4: Can utilize cheap and abundant organic feed materials. S5: Flexible production system, ranging from household scale to large industries.	W1: Vulnerable to pest attacks (ants, birds, rats). W2: Lack of consumer education on the benefits of worms and their derivative products. W3: Cultivation management requires specialized skills in media and feed management. W4: Production inconsistencies resulting from environmental variations, particularly changes in ambient temperature and humidity, which directly affect worm metabolism and productivity.
Opportunities (O)	S-O Strategies	WO Strategies
O1: The growing trend of organic cultivation, which requires worm castings as fertilizer. O2: Development of cultivation technology, such as IoT for environmental monitoring. O3: Market expansion through digital marketing and e-commerce. O4: Partnerships with the livestock and agricultural sectors for business integration.	- Increase production capacity by leveraging the organic cultivation trend. - Develop processed products such as worm extract, worm flour, and liquid fertilizer to add economic value. - Adopt IoT technology for monitoring humidity and temperature in cultivation media. - Expand digital marketing and e-commerce to reach a broader market.	- Enhance education and training for farmers to reduce the risk of cultivation failure. - Develop pest protection systems using environmentally friendly control technologies. - Utilize social media and marketplaces to introduce products to a wider consumer base. - Establish partnerships with research institutions for innovations in cultivation management.
Threats (T)	ST Strategies	WT Strategies
T1: Price fluctuations affecting product competitiveness. T2: Strict export regulations in worm-based product trade. T3: Competition from substitute products in the fertilizer and livestock feed industries. T4: Dependence on a stable supply of organic feed materials.	- Build partnerships with farmers and livestock breeders to maintain stable product demand. - Implement product diversification to avoid reliance on a single market segment. - Conduct product education and promotion to raise consumer awareness of the benefits of ANC worms. - Align production with export regulations to access international markets.	- Provide training programs for new breeders to improve cultivation success rates. - Improve production management systems to be more efficient and less dependent on external factors. - Develop storage and processing systems to extend product shelf life and withstand market fluctuations. - Strengthen distribution and logistics networks to ensure efficiency and stability.

These strategies were formulated based on the weighted SWOT scores and stakeholder validation, ensuring that each aligns with both internal conditions and external market realities.

Recommended Business Strategy

Business development strategies can be formulated based on the quadrant in which the business is positioned after conducting a SWOT analysis. To determine the business position in the SWOT Matrix, the following formula is used:

S - W = 2.15 - 1.00 = +1.15

O - T = 2.15 - 1.00 = +1.15

These numbers above are obtained from the SWOT analysis calculations (Table 4) by utilizing the weight of each factor, derived from the results of a Focus Group Discussion (FGD) with stakeholders involved in the ANC earthworm cultivation business. Weighting SWOT factors using participatory tools increases transparency and legitimacy in priority setting for agribusiness development (Stacchini et al., 2022). Additionally, the ranking of each factor is considered based on expert interviews with specialists in ANC earthworm cultivation and marketing.

The multiplication of the weight and rating values results in the score for each factor, producing the values above. The results of the SWOT weighting and rating were used to determine the firm's strategic position in a structured matrix. Since the final results are positive on both axes (X and Y), the business falls into Quadrant (Q) I (Growth/Expansion Strategy), indicating that it has significant strengths and opportunities for further development (Figure 2). Although the (S–W) and (O–T) difference scores are numerically equivalent, a deeper analysis reveals that the types of strengths and opportunities CV RAJ possesses—such as scalable production techniques, ease of adoption, and the rising interest in organic fertilizers—are more proactive in nature. Meanwhile, some weaknesses and threats, like limited market education and price volatility, are reactive and external. This asymmetry suggests that, strategically, the firm is better equipped to leverage its proactive assets than to counter its reactive vulnerabilities, thereby reinforcing its positioning in Quadrant I (Growth/Expansion Strategy). Integrating SWOT analysis with local stakeholder input helps ensure that strategic recommendations are context-specific and community-driven (Calzada, 2023). Nevertheless, these equal deltas imply a need for vigilance, particularly in strengthening organizational resilience and customer education.

Table 4. SWOT Quantitative Scores and Positioning (Primary Research Data, 2024)

SWOT Factors	Weight (∑=1)	Rating (1-4)	Score (Weight x Rating)
Strengths (S)			
S1	0.15	4	0.60
S2	0.20	4	0.80
S3	0.15	3	0.45
S4	0.10	3	0.30
Total Strengths (S)	0.60		2.15
Weaknesses (W)			
W1	0.10	2	0.20
W2	0.10	3	0.30
W3	0.10	2	0.20
W4	0.10	3	0.30
Total Weaknesses (W)	0.40		1.00
Opportunities (O)			
O1	0.20	4	0.80
O2	0.15	3	0.45
O3	0.10	3	0.30
O4	0.15	4	0.60
Total Opportunities (O)	0.60		2.15
Threats (T)			
T1	0.10	3	0.30
T2	0.10	2	0.20
T3	0.10	2	0.20
T4	0.10	3	0.30
Total Threats (T)	0.40		1.00

To ensure a more coherent and evidence-based institutional strengthening plan, the following matrix (Table 5) outlines strategy recommendations that are directly derived from the SWOT analysis. By mapping internal and external factors to specific strategy types (SO, ST, WO, WT), this matrix aims to provide a practical framework to guide future development interventions in ANC worm cultivation. The quantitative dimension of the SWOT analysis is summarized below, providing the basis for strategic quadrant positioning.

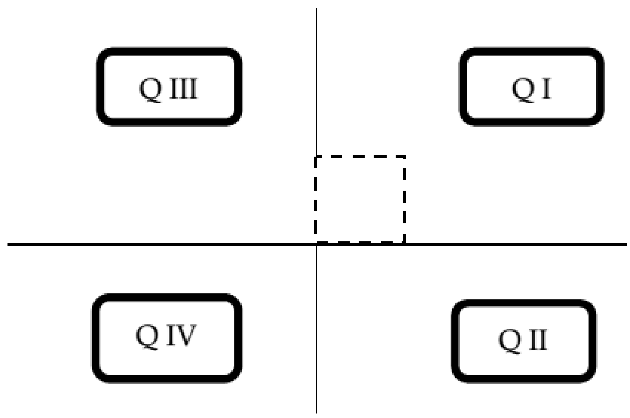

Figure 2. SWOT quadrant positioning

Table 5. Recommended Strategies

Strategy	Supporting "S"	Addressed "W"	Leverage "O"	Countered "T"
Implement IoT-based monitoring system	S3: Easy-to-apply cultivation system	W1: Limited digital literacy among workers (improved via training)	O2: Emerging agri-tech market	T1: Environmental risks (can be mitigated by better monitoring)
Use e-commerce platforms for marketing	S5: High product diversity	W2: Lack of market education	O3: Growing demand for organic fertilizer	T2: Market price fluctuations (can be reduced through broader customer base)
Develop feed procurement partnerships	S4: Strong network with local farmers	W3: Inconsistent feed supply	O4: Potential collaboration with livestock sector	T3: Dependency on few suppliers

The recommended strategies demonstrate clear linkages between the identified SWOT factors and practical actions to improve ANC worm agribusiness performance. The implementation of IoT-based environmental monitoring systems is aligned with the business's internal strength (S3) of having a simple and adaptable cultivation model. This strategy also addresses weakness (W1)—limited digital literacy among workers—by incorporating targeted training and demonstration-based extension programs, which have been shown to enhance technology adoption among farmers (Febrianti et al., 2024). Based on research by Rosada et al. (2024), agricultural extension workers play a crucial role not only in technology transfer but also in strengthening farmer institutions and market linkages. This strategy also capitalizes on the opportunity (O2) provided by emerging agricultural technology markets and helps mitigate environmental risks (T1) such as fluctuations in moisture and temperature, which are critical in worm cultivation. As shown in related agricultural innovations, IoT systems have been successfully applied for irrigation and environmental control, and can similarly be adapted for worm media monitoring (Handini et al., 2024). The application of IoT and precision agriculture technologies in small-scale systems has demonstrated positive outcomes in improving productivity and input efficiency (Munz & Schuele, 2022).

The second strategy—utilizing e-commerce platforms for marketing—builds on the strength of product diversity (S5) to address the weakness of limited market education (W2). Digital marketing and e-commerce have become critical tools for agricultural SMEs to access broader markets and differentiate niche organic products (Morepje et al., 2024). By expanding market access and awareness through platforms like Shopee and Tokopedia, the business can leverage the growing demand for organic fertilizers (O3) and reduce vulnerability to price fluctuations (T2). Lastly, the strategy to develop feed procurement partnerships strengthens the existing farmer network (S4) to overcome inconsistent feed supply (W3). It also takes advantage of potential collaboration with the livestock sector (O4) and reduces dependence on limited suppliers (T3), thereby promoting input stability and supply chain resilience. Collaborative procurement models involving farmers, processors, and input suppliers are effective in reducing transaction costs and ensuring supply stability (Nha Trang et al., 2022).

Conclusion

The study concludes that ANC worm agribusiness at CV Rumah Alam Jaya holds strong potential for sustainable development, as reflected in its SWOT position within the Growth/Expansion quadrant. This positioning is supported by internal strengths such as scalable cultivation systems, diversified product opportunities, and low-cost organic feed resources, along with external opportunities like rising demand for organic farming inputs and expanding digital markets. However, challenges such as pest infestations, environmental instability, and limited consumer awareness remain critical threats and weaknesses. To address these, specific strategies are proposed: using IoT-based sensors to control environmental conditions, applying multi-tier rack cultivation to improve space efficiency, conducting consumer education through digital platforms, and establishing formal partnerships with local suppliers and farming groups to ensure stable input and output flows. These strategies directly respond to the SWOT findings and are grounded in participatory assessments involving stakeholders and experts. The research contributes novelty by offering a comprehensive model that integrates biological, commercial, and institutional dimensions of ANC worm cultivation, providing practical insights for scaling up environmentally friendly agribusiness ventures in Indonesia. A holistic agribusiness model that integrates biological efficiency, market alignment, and institutional strengthening is essential for long-term sustainability in the worm cultivation sector. This study contributes novelty by integrating technical, commercial, and institutional perspectives into a unified agribusiness strategy for sustainable ANC worm cultivation. This strategic integration model could also serve as a replicable framework for other small-scale agribusinesses aiming to transition toward more sustainable, value-added operations.

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References

Amruddin, A. (2025). Science Applied in Agricultural Modernization and Poverty in Suburban Villages. *Jurnal Penelitian Pendidikan IPA*, *11*(3), 837–843. https://doi.org/10.29303/jppipa.v11i3.10603

Anusha, M., Preethee, S., Saminathan, K., Kathireswari, P., & Arunmetha, S. (2023). Vermi degradation of different dietary supplements mediated on the reproduction and metabolic profile of earthworm Eudrilus eugeniae. *Notulae Scientia Biologicae*, *15*(4), 1–17. https://doi.org/10.55779/nsb15411638

Anwar, Y., Jatsiyah, V., M. Zahari, Saefudin, A., & Nofirman, N. (2023). Transforming Traditional Farmers into Professionals: An Introduction to Human Resource Management in Rural. *Jurnal Penelitian Pendidikan IPA*, *9*(12), 12266–12275. https://doi.org/10.29303/jppipa.v9i12.6543

Argyroudis, S. A., Mitoulis, S. A., Chatzi, E., Baker, J. W., Brilakis, I., Gkoumas, K., Vousdoukas, M., Hynes, W., Carluccio, S., Keou, O., Frangopol, D. M., & Linkov, I. (2022). Digital technologies can enhance climate resilience of critical infrastructure. *Climate Risk Management*, *35*, 100387. https://doi.org/10.1016/j.crm.2021.100387

Baylon, N., & Catian, I. (2019). Population Growth rate of African Night (Eudrilus eugeniae) Crawler Fed with Different Leguminous Leaves as Supplement. *Philippine Journal of Agricultural Economics*, *3*(1), 52–64. https://doi.org/10.7719/pjae.v3i1.671

Bellitürk, K., & Sundari, R. S. (2024). The power of earthworm: vermicompost drives to sustainable agriculture. In *Earthworm Technology in Organic Waste Management* (pp. 307–321). Elsevier. https://doi.org/10.1016/B978-0-443-16050-9.00018-9

Blakemore, R. J. (2015). Eco-taxonomic profile of an iconic vermicomposter—the 'African nightcrawler' earthworm, Eudrilus eugeniae (Kinberg, 1867). *African Invertebrates*, *56*(3), 527–548. https://doi.org/10.5733/afin.056.0302

Brenya, R., Akomea-Frimpong, I., Ofosu, D., & Adeabah, D. (2023). Barriers to sustainable agribusiness: a systematic review and conceptual framework. *Journal of Agribusiness in Developing and Emerging Economies*, *13*(4), 570–589. https://doi.org/10.1108/JADEE-08-2021-0191

Calzada, I. (2023). Smart Rural Communities: Action Research in Colombia and Mozambique. *Sustainability (Switzerland)*, *15*(12), 1–23. https://doi.org/10.3390/su15129521

Chaudhuri, P. (2019). Earthworm Technology---A Promising Tool for Second Green Revolution. In A. S. Kalamdhad, J. Singh, & K. Dhamodharan (Eds.), *Advances in Waste Management* (pp. 1–15). Springer Singapore.

Dini, I. R., Saputra, R., Hapsoh, H., Salbiah, D., Yoseva, S., & Masjudi, H. (2024). Assistance for Oyster Mushroom Entrepreneurs in Making Fish Feed Formulations for African Night Crawler Worm (ANC) and Trichoderma sp. Fermented Bran. *Journal of Saintech Transfer*, *6*(2), 51–57. https://doi.org/10.32734/jst.v6i2.10223

Dissanayaka, D. M. N. S., Udumann, S. S., & Atapattu, A. J. (2024). Synergies Between Tree Crops and Ecosystems in Tropical Agroforestry. In *Agroforestry* (pp. 49–87). John Wiley & Sons, Ltd. https://doi.org/10.1002/9781394231164.ch3

Febrianti, T., Rahmawati, F., Mukhlis, M., & Suryana, D. (2024). Socio-Economic Factors Influencing the Adoption of Integrated Crop Management Technology in Rice For Sustainable Agribusiness Development. *Jurnal Penelitian Pendidikan IPA*, *10*(8), 5984–5991. https://doi.org/10.29303/jppipa.v10i8.8123

Handini, W., Widanti, N., Lestari, S. W., Haqq, A. R., & Hafizh, A. (2024). Prototype Design of Micro Hydro Power Plant with Utilization of Irrigation Water in Rice Fields Based on IoT. *Jurnal Penelitian Pendidikan IPA*, *10*(9), 7144–7150. https://doi.org/10.29303/jppipa.v10i9.8553

Idris, A. P. (2024). Substitution of Fish Meal and Worm Meal African Night Crawler on the Physical Quality of Fish Feed. *International Journal of Life Science and Agriculture Research*, *03*(03), 204–210. https://doi.org/10.55677/ijlsar/v03i3y2024-12

Kabi, F., Kayima, D., Kigozi, A., Mpingirika, E. Z., Kayiwa, R., & Okello, D. (2018). Effect of Different Organic Substrates on Reproductive Biology, Growth and Offtake of the African Night Crawler Earthworm (Eudrilus eugeniae). In *Ecological and Organic Agriculture Strategies for Viable Continental and National Development in the Context of the African Union's Agenda 2063* (pp. 37–42). Retrieved from https://orgprints.org/id/eprint/33629/

Kamar Zaman, A. M., & Yaacob, J. S. (2022). Exploring the potential of vermicompost as a sustainable strategy in circular economy: improving plants' bioactive properties and boosting agricultural yield and quality. *Environmental Science and Pollution Research*, *29*(9), 12948–12964. https://doi.org/10.1007/s11356-021-18006-z

Kavitha, P. (2023). Vermicomposting: A Leading Feasible Entrepreneurship. In *Agricultural Microbiology Based Entrepreneurship : Making Money from Microbes* (pp. 289–306). Springer Nature Singapore. https://doi.org/10.1007/978-981-19-5747-5_18

Khan, F. A., Tomar, A., Agarwal, Y. K., & Shukla, H. O. (2020). Agricultural Solid Waste Management: An Approach to Protect the Environment and Increase Agricultural Productivity. In *Handbook of Solid Waste Management: Sustainability through Circular Economy* (pp. 1–27). Springer Singapore. https://doi.org/10.1007/978-981-15-7525-9_28-1

Le, T. M. T., Hoang, D. A., Nguyen, H. P., Trinh, V. Van, Tran, T. H., Dang, T. M. A., & Ha, T. Q. (2020). Using cassava waste of the cassava starch processing as food for raising African Nightcrawler (Eudrilus eugeniae) to obtain vermicomposting and earthworm biomass. *Journal of Vietnamese Environment*, *12*(2), 169–176. https://doi.org/10.13141/jve.vol12.no2.pp169-176

Macabuhay, M. A. A., Abellera, M. T. R., & Ticsay, A. E. (2016). Development of an automated production of african night Crawler's vermicast with android application. *Lecture Notes in Engineering and Computer Science*, *2223*, 363–368. Retrieved from https://www.iaeng.org/publication/WCE2016/WCE2016_pp363-368.pdf

Morepje, M. T., Sithole, M. Z., Msweli, N. S., & Agholor, A. I. (2024). The Influence of E-Commerce Platforms on Sustainable Agriculture Practices among Smallholder Farmers in Sub-Saharan Africa. In *Sustainability* (Vol. 16, Issue 15). https://doi.org/10.3390/su16156496

Muala, B., Antara, M., & Laapo, A. (2024). Sustainability Strategy for Organic Development in Banggai Regency. *Jurnal Penelitian Pendidikan IPA*, *10*(11), 9242–9256. https://doi.org/10.29303/jppipa.v10i11.9387

Munz, J., & Schuele, H. (2022). Influencing the Success of Precision Farming Technology Adoption—A Model-Based Investigation of Economic Success Factors in Small-Scale Agriculture. In *Agriculture* (Vol. 12, Issue 11). https://doi.org/10.3390/agriculture12111773

Nha Trang, N. T., Nguyen, T.-T., Pham, H. V, Anh Cao, T. T., Trinh Thi, T. H., & Shahreki, J. (2022). Impacts of Collaborative Partnership on the Performance of Cold Supply Chains of Agriculture and Foods: Literature Review. In *Sustainability* (Vol. 14, Issue 11). https://doi.org/10.3390/su14116462

Plaas, E., Meyer-Wolfarth, F., Banse, M., Bengtsson, J., Bergmann, H., Faber, J., Potthoff, M., Runge, T., Schrader, S., & Taylor, A. (2019). Towards valuation of biodiversity in agricultural soils: A case for earthworms. *Ecological Economics*, *159*, 291–300. https://doi.org/10.1016/j.ecolecon.2019.02.003

Ponsen, S., Wongchantra, P., & Aengwanich, W. (2023). The influence of ambient temperature and polyphenols from plant leaves on growth and the response to oxidative and nitrosative stress in African nightcrawler earthworm, Eudrilus eugeniae (Kinberg, 1867). *International Journal of Biometeorology*, *67*(4), 705–716. https://doi.org/10.1007/s00484-023-02448-w

Purnama, S. M., Mulyadi, F., Inggrida, J. A., Purwanto, E., Nadhirah, A., & Islamy, R. A. (2023). Factors that Affect the Income Generation of Organic Rice Farmers in The Village of Pagung. *Jurnal Penelitian Pendidikan IPA*, *9*(8), 6028–6034. https://doi.org/10.29303/jppipa.v9i8.4896

Rasyid, I., Wirawan, I., & Sirajuddin, S. N. (2024). Accessibility of Sustainable Beef Cattle Business Development in Mattiro Bulu District, Pinrang Regency. *Jurnal Penelitian Pendidikan IPA*, *10*(6), 7688–7695. https://doi.org/10.29303/jppipa.v10i10.9083

Rohani, S., Nurlaelah, S., Sirajuddin, S. N., & Syarif, I. (2024). Internal and External Factors in Developing Farmer Businesses in Pinrang Regency, South Sulawesi Province , Indonesia (Case Study). *Jurnal Penelitian Pendidikan IPA*, *10*(12), 10386–10393. https://doi.org/10.29303/jppipa.v10i12.9116

Rosada, I., Rasyid, R., Amran, F. D., & Sirajuddin, S. N. (2024). Effectiveness of the role of agricultural extension workers in clove cultivation in Enrekang Regency (Case study in Buntu Barana Village, Curio District, Enrekang Regency). *Jurnal Penelitian Pendidikan IPA*, *10*(11), 8837–8846. https://doi.org/10.29303/jppipa.v10i11.9074

Sherman, R. (2018). *The Worm Farmer's Handbook: Mid- to Large-Scale Vermicomposting for Farms, Businesses, Municipalities, Schools, and Institutions*. Chelsea Green Publishing.

Sholikin, M., Batoro, J., Anggayasti, W. L., & Pertiwi, M. (2024). Cattle Waste Management Strategy for Environmental Health in Pucangarum Village, Baureno District, Bojonegoro Regency. *Jurnal Penelitian Pendidikan IPA*, *10*(5), 2727–2735. https://doi.org/10.29303/jppipa.v10i5.6739

Stacchini, A., Guizzardi, A., & Mariotti, A. (2022). Smoothing down arbitrariness in planning: From SWOT to participatory decision making. *Land Use Policy*, *119*, 106213. https://doi.org/10.1016/j.landusepol.2022.106213

Steckley, J. (2022). Nightcrawler commodities: A brief history on the commodification of the humble dew worm. *Environment and Planning E: Nature and Space*, *5*(3), 1361–1382. https://doi.org/10.1177/25148486211031341

Strijker, D., Bosworth, G., & Bouter, G. (2020). Research methods in rural studies: Qualitative, quantitative and mixed methods. *Journal of Rural Studies*, *78*, 262–270. https://doi.org/10.1016/j.jrurstud.2020.06.007

Sun, M., Chao, H., Zheng, X., Deng, S., Ye, M., & Hu, F. (2020). Ecological role of earthworm intestinal bacteria in terrestrial environments: A review. *Science of The Total Environment*, *740*, 140008. https://doi.org/10.1016/j.scitotenv.2020.140008

Suranto, S., & Pratiwi, A. (2023). Empowerment Model to Enhance Food Self-Sufficiency at Mushroom Industry Center. *Jurnal Penelitian Pendidikan IPA*, *9*(SpecialIssue), 525–532.

https://doi.org/10.29303/jppipa.v9ispecialissue.5629

Tekle, A., Areaya, S., & Habtamu, G. (2024). Enhancing Stakeholders' Engagement in TVET Policy and Strategy Development in Ethiopia. *Journal of Technical Education and Training*, *16*(1), 271–285. https://doi.org/10.30880/jtet.2024.16.01.019

Tyagi, K. S., Singh, D. P., & Gupta, R. K. (2023). Rural Entrepreneurship through Vermicomposting – Case Studies. *Dev Sanskriti Interdisciplinary International Journal*, *22*(c), 06–11. https://doi.org/10.36018/dsiij.22.239

Wang, X.-M., Fan, S.-C., Chen, Y., Ma, X.-F., & He, R.-Q. (2019). Earthworm protease in anti-thrombosis and anti-fibrosis. *Biochimica et Biophysica Acta (BBA) - General Subjects*, *1863*(2), 379–383. https://doi.org/10.1016/j.bbagen.2018.11.006

Zarafshani, K., Sahraee, M., & Helms, M. (2015). Strategic Potential of the Vermicompost Agribusiness in Iran: A SWOT Analysis TT -. *Journal of Agricultural Science and Technology*, *17*(6), 1393–1408. Retrieved from http://jast.modares.ac.ir/article-23-12285-en.html