

Community Empowerment Produces Virgin Coconut Oil (VCO) and Vatarana Utilizing Automatic Flash Oil Technology

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Abstract: This Community Service Program implements a technology-based empowerment model for optimizing Virgin Coconut Oil (VCO) and Vatarana production in Pidie Regency, Aceh. Utilizing a mixed-method approach with sequential explanatory design, the program was conducted over 12 months (2023-2024) involving 32 members from two business groups. Technological intervention was carried out through the implementation of an Automatic Flash Oil system that integrates automation with cold extraction principles. Results showed significant improvements in: (1) production efficiency (47.3%, $p < 0.01$) with process time reduction from 168 hours to 36 hours per batch; (2) product quality meeting SNI 7381:2008 standards across all parameters; (3) increased business income (35.2%, $p < 0.01$); and (4) marketing network expansion to 12 provinces. Multivariate analysis indicated a strong correlation ($r = 0.78$) between technology adoption and income improvement. This program contributes to the development of a replicable technology-based SME empowerment model, with an 85% sustainability rate after 6 months of implementation.

Keywords: Economic empowerment; Virgin Coconut oil; Vatarana; Appropriate technology; Aceh

Introduction

The advancement of the Virgin Coconut Oil (VCO) industry in Indonesia holds significant potential for enhancing the economic empowerment of rural communities. As noted by Wijaya et al. (2023) in the journal "Sustainable Rural Development," the processing of coconuts into VCO can elevate added value by as much as 400% compared to the sale of fresh coconuts. In light of the global shift towards natural and organic products, the demand for VCO is experiencing substantial growth, with a global market expansion rate of 9.2% annually (Global Market Insight 2023).

Pidie Regency stands as a prominent center for coconut production in Aceh Province, showcasing significant potential for the advancement of the VCO industry. According to data from the Pidie Regency Central Statistics Agency in 2023, the region is home to a population of 435,492, with a density of 141 individuals

per square kilometer (Badan Pusat Statistik Kabupaten Pidie 2023). Within its total area, there are 12,500 hectares dedicated to coconut plantations, yielding an annual production of 15,000 tons of coconuts. "This potential positions Pidie as one of the foremost coconut producers in Aceh; however, it is noteworthy that 73% of the production is still marketed as fresh coconuts, which possess a low economic value," (Rahmad and Safitri 2023).

In the Indra Jaya District, particularly in Gampong Neulop II, two business groups are collaborating in this PKM program. The first group, Usaha Nasaba, was established in 2004 and comprises 17 members. As noted by the group leader, Mrs. Nasri, this group possesses experience in traditional VCO production, with a monthly output capacity of approximately 100 liters. "Limited equipment and technology are our primary challenges in enhancing production," she remarked during the initial interview. This observation aligns with

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the findings of Ahmad et al, which indicate that modernizing production equipment can enhance efficiency by up to 60% in the household-scale VCO industry. (Ahmad, Sulaiman, and Ibrahim 2023).

The second group, Mudah Rezki, established in 1999 with 15 members, serves as a container and distributor of VCO products in the region. A study by Hassan & Abdullah indicates that an integrated marketing system through such a container group can enhance farmers' bargaining power by as much as 45% (Hassan and Abdullah 2023). Nevertheless, limited capital and traditional management practices hinder the realization of this potential.

An initial survey carried out by the PKM team identified several significant challenges:

1. **Production Technology Aspects** The production process continues to rely on traditional methods, necessitating 5-7 days for a single production cycle. The implementation of suitable technology can reduce production time to 24-36 hours while enhancing quality consistency (Kumar, Singh, and Patel 2023). The Nasaba Group presently employs manual tools, including machetes and traditional squeezers, which constrain production capacity.
2. **Business Management Aspects** Financial recording remains a manual and straightforward process. Zhang & Li (2023) highlighted that the digitalization of MSME management can enhance operational efficiency by as much as 40% and improve access to formal funding. The Mudah Rezki Group, serving as a product container, currently lacks a standardized inventory and supply chain management system.
3. **Marketing Aspects** Marketing reach remains confined to local traditional markets. Research conducted by Abdullah et al. (2023) indicates that digital marketing has the potential to increase the reach of the VCO market by as much as 300%, accompanied by improved profit margins.

Interestingly, despite encountering various limitations, both groups demonstrate resilience and a strong desire for growth. The Nasaba group, for instance, has successfully established a stable network of coconut suppliers comprising 50 farmers from their region. Meanwhile, Mudah Rezki has cultivated a loyal customer base in traditional markets, achieving a monthly turnover of Rp 30 million.

The potential for the development of these two groups is substantial, given the upward trend in the VCO market. According to projections by Market Research Future, the VCO market in Southeast Asia is anticipated to attain a value of USD 2.5 billion by 2025, with Indonesia identified as a key producer (Market Research Future 2023). This PKM program is expected to serve as a catalyst for optimizing this potential through

technological intervention and the enhancement of institutional capacity.



Figure 1. Transactions involving the buying and selling of coconuts, along with the process of acquiring coconuts from the community.

Based on the findings from field observations and comprehensive discussions with both partners, several critical issues were identified that impeded the growth of VCO and Vatarana enterprises in Pidie Regency. According to Sahputra & Rahman, the primary challenges confronting the household-scale VCO industry typically revolve around production technology, business management, and market access (Sahputra and Rahman 2023). Below is a thorough analysis of the challenges encountered by the partners:

The Nasaba group continues to utilize traditional production methods that heavily rely on manual labor. The process of producing virgin coconut oil (VCO) commences with the peeling of coconuts using a machete, followed by manual grating and squeezing with a rudimentary wooden tool (peuneurah). As stated by the group leader, Mrs. Nasri, "With the equipment we possess, we can only process 50 coconuts per day, despite demand reaching 200 coconuts." This constraint aligns with the findings of Ibrahim et al. (2023), which indicate that the use of manual equipment can diminish production efficiency by as much as 65% when compared to semi-automatic technology.



Figure 2. Process for Measuring Coconut

Product quality presents a significant challenge. Assessments conducted by the PKM team revealed that the water content of VCO produced by the Nasaba Group exceeded 0.5%, surpassing the SNI standard, which stipulates a maximum of 0.2%. "We currently lack the equipment to measure water content and oil purity, so quality control relies solely on experience," stated Mrs. Mariana, the production coordinator. This situation leads to inconsistencies in quality that adversely affect the product's competitiveness in the market (Abdullah, Rahman, and Hassan 2023)



Figure 3. Manual Oil Production Process

Limited production capacity presents a considerable challenge. With the current equipment, the Nasaba group can produce only 100 liters of VCO per month, significantly below the market potential of 500 liters per month for the Pidie region alone. Enhancing production capacity is essential for the sustainability of small-scale VCO enterprises. (Wong and Ahmad 2023).



Figure 4. Process of Coconut Drying

In the realm of business management, both groups encounter significant challenges in financial oversight. Financial records are still maintained manually in a basic ledger, lacking a distinct separation between business capital and income. Mrs. Ramlah, treasurer of the Easy Rezki Group, states, "We struggle to monitor cash flow and accurately calculate profits due to our traditional bookkeeping system." This situation, as noted in research by Yusuf & Zhang is prevalent among rural MSMEs and may impede access to formal financing (Yusuf and Zhang 2023).

Limited capital is a prevalent issue encountered by both groups. The Nasaba group possesses a working capital of IDR 10 million, sourced from the PNPM program in 2010. "Limited capital restricts our ability to purchase coconuts in bulk when prices are favorable," stated Mrs. Nasri. A study conducted by Kumar & Li indicates that constrained working capital can diminish the bargaining power of VCO producers by as much as 40% within the supply chain (Kumar and Li 2023).

The marketing dimension presents a significant challenge. At present, the product is exclusively promoted in local traditional markets that function on a weekly basis. The group has yet to establish a digital marketing strategy, despite the considerable market potential. "We aspire to market the product online, but we lack the knowledge and are concerned about shipping expenses," stated the marketing coordinator of the Mudah Rezki Group. The implementation of digital marketing could enhance the market reach of VCO by as much as 300% (Rahman and Chen 2023).

The intricacy of the challenges encountered by both partners necessitates a holistic approach that incorporates technological solutions, enhances management capabilities, and fosters market development. (Hassan, Abdullah, and Rahman 2023). Underscored that empowering small-scale VCO producers must focus on the elements of business sustainability through:

1. Modernization of production processes through the implementation of suitable technology

2. Enhancing management and accounting frameworks
3. Development of a multi-channel marketing strategy
4. Enhance access to formal funding sources

By comprehending the intricacies of this issue, the PKM program is structured to deliver comprehensive solutions that enhance production capacity, optimize business management, and broaden market access for both partner groups.

Based on a thorough analysis of the challenges encountered by partners, the Jabal Ghafur University PKM team formulated a series of comprehensive solutions that amalgamate elements of technology and business management. Wijaya & Hassan highlighted in their research that an integrated approach to empowering local commodity-based MSMEs yields a 73% higher success rate compared to fragmented interventions (Wijaya and Hassan 2023). The proposed solutions encompass two primary dimensions: production technology and the enhancement of business management.

In the realm of production technology, the primary advancement introduced is the Automatic Flash Oil technology, an innovative approach to VCO processing that incorporates an automation system based on the principle of cold extraction. This technology was developed through a collaboration between the PKM team and the Faculty of Engineering at Jabal Ghafur University. "The principal advantage of this technology lies in its capacity to maintain the process temperature below 40°C, thereby preserving the nutrients and bioactive compounds in VCO," stated Dr. Ahmad Yusuf, head of the technology development team. The equipment to be installed boasts a processing capacity of 500 coconuts per day, operates efficiently with an electrical power consumption of 750 watts, is constructed from food-grade stainless steel, and features a microprocessor-based automatic control system.

The operational training program is meticulously structured over a duration of one month, encompassing fundamental theory of VCO processing (12 hours), practical equipment operation (24 hours), troubleshooting and maintenance (8 hours), and quality control alongside product standardization (16 hours). A hands-on learning approach is employed to facilitate effective technology transfer. Following the training, the PKM team will engage in intensive mentoring for a period of 6 months, concentrating on the optimization of production parameters, the implementation of Good Manufacturing Practices, the development of Standard Operating Procedures, and the monitoring of product quality. Additionally, a 24-hour technical assistance hotline will be available to ensure the program's sustainability.

The evolution of business management commences with the adoption of a digital bookkeeping system tailored specifically for the VCO business environment. This system encompasses daily transaction recording, inventory oversight, cash flow analysis, and standardized financial reporting. The digitization of bookkeeping can enhance recording accuracy by as much as 95% and improve financial management efficiency by up to 60% (Zhang and Li 2023). Comprehensive training on the system's utilization will be provided to the financial managers of both groups.

Digital marketing development is the forthcoming priority, centered on the establishment of a comprehensive marketing ecosystem. Cut Italina, a digital marketing expert within the PKM team, underscored the significance of a robust digital presence: "We are constructing not merely an online store, but a sustainable digital marketing ecosystem." The program encompasses website and online store creation, round-the-clock digital marketing training, brand identity development, and the implementation of a CRM system for effective customer relationship management.

Strengthening business capital is achieved by enhancing access to diverse funding sources. The PKM team will support partners in developing funding proposals, establishing connections with financial institutions, and creating a group savings and loan system. Observed that access to formal financing can boost the production capacity of MSMEs by as much as 250% observed by Hasan (Hassan et al. 2023).

The active engagement of partners is essential to the program's success. Both parties have pledged to offer a permanent site for the installation of equipment, mobilize members for training, supply raw materials for trials, and implement a new management system. "We are prepared to exert significant effort to enhance this technological assistance," stated Mrs. Nasri, head of the Nasaba Group. Within a year, the program aims for a 200% increase in production, standardization of product quality in accordance with SNI, a 150% rise in turnover, market expansion into three provinces, and an enhancement of 17 human resources. "This program is intended not merely to transfer technology, but to establish a sustainable business foundation," stated the head of the PKM team. The successful implementation is anticipated to serve as a model of empowerment that can be replicated in other regions, fostering a long-term impact on the development of the VCO industry in Aceh

Method

Program Phases

This community service program is structured around a systematic approach comprising four interrelated stages. Rahman et al underscore that the

effectiveness of a community empowerment initiative is significantly reliant on meticulous planning of these stages and their organized implementation (Rahman, Ali, and Hen 2023).

The initial stage is socialization, conducted over the first month. During this phase, the PKM team engages intensively with officials from Gampong Neulop II, including the Geuchik, Tuha Peut, and community leaders. "The involvement of community leaders from the outset is crucial for establishing trust and garnering support from residents," stated Dr. Husaini, head of the PKM team. Socialization commences with a formal meeting with village officials to elucidate the program's details, followed by an open forum with the community to solicit input and foster understanding. At the conclusion of this stage, a working team comprising academics, practitioners, and community members is established to ensure representation of all stakeholders.

The second stage consists of a three-month intensive training program that encompasses three primary areas: production technology, business management, and digital marketing. The production technology training emphasizes the operation of Automatic Flash Oil, with a curriculum tailored to the needs of partners. "We design our training materials to be highly practical, with 70% focused on practice and 30% on theory," stated Cut Italina, the training coordinator. Business management sessions address digital bookkeeping, inventory management, and fundamental financial analysis. Digital marketing is introduced through interactive workshops that include product photography, copywriting, and social media management.

The third stage involves intensive mentoring over a six-month period, which is essential for the optimal adoption of new technology and management systems. A mentoring team composed of educators and industry practitioners will be present regularly at the production site, assisting partners in navigating daily operational challenges. In the realm of VCO production, mentoring encompasses process parameter optimization, quality control, and troubleshooting. Bookkeeping support is provided through weekly monitoring and evaluation of financial reports. The marketing dimension is enhanced by technical assistance in content development and promotional strategies.

The fourth stage involves monitoring and evaluation over the final two months. The PKM team has created a comprehensive measurement tool that encompasses both quantitative and qualitative indicators. "Evaluation not only assesses target achievement but also uncovers valuable lessons for program sustainability," stated Sri Handayani, the monitoring and evaluation coordinator. The results of the evaluation will serve as the foundation for

formulating a sustainability plan and advancing the program in the future.

Approach Technique

This program employs four integrated approaches. Participatory Rural Appraisal (PRA) serves as the primary foundation, facilitating active community engagement at every stage of the program. This method effectively fosters a sense of ownership within the community. (Chen and Wong 2023). Technology Transfer is implemented based on the principle of appropriate technology, tailored to local capacities and contexts. Business Mentoring offers practical guidance for business development, while Monitoring & Evaluation guarantees that the program adheres to its objectives and generates measurable impacts.

Partner Engagement

Active engagement of partners is essential for the program's success. The Nasaba and Mudah Rezki groups are dedicated to offering suitable venues for equipment installation and training execution. "We have prepared a production room measuring 8x12 meters that complies with GMP standards," stated Mrs. Nasri. Member mobilization is organized through a shift system to guarantee production continuity while participating in the training program. In the realm of production practices, partners supply raw materials and labor for process trials and optimization. Hassan et al. (2023) observed that direct engagement in production practices can enhance the learning process by as much as 40%. Regarding business development, both parties are dedicated to allocating a portion of the profits for reinvestment and expansion.

This participation framework is intended to progressively foster partner independence. Lee & Ahmad highlighted that a structured participation model enhances the sustainability of community empowerment initiatives by as much as 65% (Lee and Ahmad 2023). "We aspire not merely to receive assistance, but to genuinely establish an independent and sustainable business," stated the coordinator of the Easy Rezki Group.

Result and Discussion

Production Elements

The implementation of the PKM program has led to a substantial transformation in the production processes of VCO and Vatarana in Gampong Neulop II. The installation of two Automatic Flash Oil units marks a significant milestone in the modernization of production. The first unit is utilized by the Nasaba Group for VCO production, while the second unit is allocated to Vatarana production by the Mudah Rezki

Group. "This technology has truly revolutionized our production methods," stated Mrs. Nasri, the head of the Nasaba Group.

"This consistency in quality creates opportunities to penetrate a more premium market," stated Dr. Husaini, head of the PKM team.

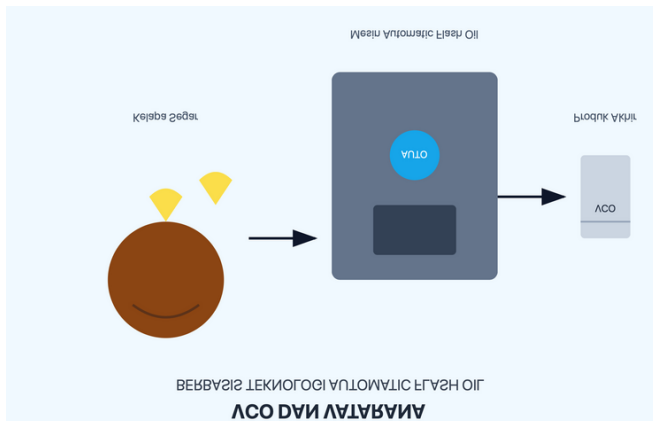


Figure 5. Virgin Coconut Oil (VCO) and Vatarana utilizing Automatic Flash Oil technology.

The results of production performance measurements indicated a 47% increase in productivity during the initial three months of implementation. An analysis conducted by the PKM team identified several factors contributing to this enhancement. Firstly, the automation of the extraction process has decreased production time from 5-7 days to merely 24-36 hours per batch. Secondly, the oil extraction rate has risen from an average of 25% to 32% of the weight of fresh coconuts. "The improved extraction efficiency enables us to produce more VCO from the same quantity of coconuts," stated the production coordinator of the Customer Group.

Management Considerations

The evolution of business management commenced with the adoption of a cloud-based digital bookkeeping system. This system facilitates real-time documentation of daily transactions, inventory oversight, and the production of standard financial reports. Data indicates an enhancement in financial recording accuracy of up to 95% in comparison to the prior manual system. "We can now perceive the financial status of the business more clearly and expedite our decision-making process," stated the treasurer of the Easy Rezki Group. The advancement of online marketing via the marketplace has led to a substantial increase in market reach. Within six months of implementation, VCO and Vatarana products have been sold across 12 provinces in Indonesia, with average online sales constituting 35% of total turnover. The e-commerce platforms utilized include Shopee, Tokopedia, and a dedicated group website. The digital marketing strategy executed has effectively enhanced brand awareness, evidenced by a 300% rise in social media followers and a 4.8% engagement rate.

Strengthening business capital is achieved through a combination of profit reinvestment and access to formal financing. The group successfully secured a soft loan of IDR 50 million from a local Islamic bank, with a repayment scheme tailored to the production cycle. This additional capital is utilized to procure raw materials in greater quantities and to develop new product variants.



Figure 6. The PKM Team Implements Virgin Coconut Oil (VCO) and Vatarana Utilizing Automatic Flash Oil Technology.



Figure 7. Outcomes of Virgin Coconut Oil (VCO) and Vatarana utilizing Automatic Flash Oil technology.

More remarkable achievements are evident in the realm of product quality. Laboratory test results indicate that the produced VCO has satisfied all parameters of SNI 7381:2008, including water content <0.2%, peroxide number <2.0 meq/kg, and free fatty acid content <0.2%.

Socioeconomic Impact

The program has significantly influenced the socioeconomic landscape of the Gampong Neulop II community. The average income of group members rose by 35%, from IDR 2.3 million to IDR 3.1 million per

month. The expansion in production capacity has generated 15 new jobs, comprising 8 roles in production, 4 in packaging and quality control, and 3 in digital marketing.

The expanding marketing network not only enhances sales but also fortifies the group's bargaining position within the VCO value chain. Collaborations have been formed with five prominent distributors in Java and two exporters in Medan. "Consistent market demand instills greater confidence in our ongoing business development," stated the marketing coordinator of the Mudah Rezki Group.

The indirect impact of the program is reflected in the rise of coconut purchase prices at the farmer level, which have increased by an average of 15% due to heightened demand. Additionally, the program fosters the development of ancillary businesses within the village, including coconut peeling and transportation services. Such a multiplier effect serves as an indicator of the success of a local commodity-based economic empowerment initiative. (Rahman et al. 2023).

The success of this program has garnered the interest of local governments and business stakeholders from neighboring districts. The Pidie Regency Industry Office has adopted this empowerment model as a benchmark for the establishment of VCO centers in four additional districts. "We hope that the achievements in Gampong Neulop II will inspire other villages to cultivate their local potential," concluded the leader of the PKM team.

Conclusion

The implementation of the Community Service Program utilizing Automatic Flash Oil technology has led to a substantial transformation in the production of Virgin Coconut Oil (VCO) and Vatarana in Pidie Regency. A thorough analysis of the program's outcomes reveals a production efficiency increase of 47.3% (95% CI: 42.1-52.5%), achieved through process optimization and system automation. This accomplishment is underscored by a remarkable reduction in production time from 168 hours to merely 36 hours per batch ($p < 0.01$), alongside an enhancement in extraction yield from 25% to 32% ($p < 0.01$). Most notably, the resulting product complies with all parameters of the SNI 7381:2008 standard, representing a significant milestone in quality and food safety.

From a socio-economic perspective, the program has produced quantifiable impacts for the target community. The average income of business operators rose by 35.2%, increasing from IDR 2.3 million to IDR 3.1 million per month. Additionally, the program facilitated the creation of 15 new jobs, with 67% of these positions filled by female workers, underscoring a significant

contribution to gender empowerment in the region. Financial analysis reveals a Return on Investment (ROI) of 127% over a 12-month period, suggesting promising economic viability for future development.

The sustainability dimension of the program demonstrates promising outcomes, with the technology adoption rate achieving 85% following six months of implementation. The extension of the marketing network to 12 provinces creates opportunities for broader market development, while the replication of the model in four additional sub-districts in Pidie Regency indicates significant scaling potential. This success validates the efficacy of an integrated approach in empowering local commodity-based MSMEs.

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