

Corporate Social Responsibility Program of PT Pertamina Patra Niaga Aviation Fuel Terminal (AFT) Ngurah Rai: Welfare Distribution for Farmers through Energy Supply Management Technology in Uma Palak Irrigation as Climate Change Mitigation

Farkha Alfa Centauri¹, Erly Yeniska Hermitasari², Tahsa Ayu Seva³, Erika Malaranti⁴

¹Supervisor HSSE PT Pertamina Patra Niaga Aviation Fuel Terminal Ngurah Rai,
Indonesia

^{2,3,4}Community Development Officer PT Pertamina Patra Niaga Aviation Fuel Terminal
Ngurah Rai, Indonesia

Email: farkha.centauri@pertamina.com

Abstract. Urban farming now serves not only as a support for urban household food security but also embodies the concept of Tri Hita Karana in the Balinese Hindu community. To sustain agriculture in Desa Adat Peguyangan, Kelurahan Peguyangan, Kecamatan Denpasar Utara, Kota Denpasar, Bali, PT Pertamina Patra Niaga Aviation Fuel Terminal Ngurah Rai implements the CSR program Uma Palak Lestari. This research employs a descriptive approach. Data collection techniques include in-depth interviews. Respondents were selected through purposive sampling, encompassing group leaders and members, community leaders, and relevant government officials. The results indicate that the Uma Palak Lestari Program by Pertamina Patra Niaga AFT Ngurah Rai has introduced innovations aimed at addressing urban agriculture challenges in Munduk Palak Subak Sembung, North Denpasar. This program, in collaboration with the Munduk Palak farmers group organized under the Joint Business Group (KUB) Uma Palak Lestari, has developed the Uma Palak Energy Supply Management Irrigation (SIUMA) technology. SIUMA is a hybrid renewable energy technology designed to adapt to climate change. SIUMA serves as a survival guide to help farmers endure drought conditions.

Keywords: *Urban Farming, Drought, Climate Change, Community Empowerment, Energy Supply, Irrigation Management.*

A. INTRODUCTION

The anthropogenic activities have driven the occurrence of extreme climate change. Climate change is a condition where several elements experience changes in magnitude or intensity, deviating from their dynamics and averages towards a certain direction, where such changes can either increase or decrease (Prihasto, 2019). Climate change arises from both natural processes and human behaviors that continuously emit greenhouse gases (GHGs), altering the composition of the atmosphere and land use, consequently leading to global warming. GHG emissions involve the release of gases with greenhouse effects into the atmosphere over a specific period. There is a need for changes in human behavior to reduce GHG emissions, thereby addressing climate change and preventing further extremities. Human efforts to address climate change can be pursued through mitigation and adaptation. Mitigation involves efforts to reduce emissions and/or enhance the absorption of greenhouse gases from various emission sources. Adaptation refers to the ability of humans, livestock, plants, or organisms to adjust to environmental changes, whether macro or micro in nature and direct or indirect impacts of climate change to continue fulfilling their biological functions (Prihasto, 2019).

Failure to promptly address climate change will increasingly impact environmental, social, and economic changes within communities. One of the sectors directly affected by the phenomenon of climate change is agriculture. The agricultural sector holds significant potential in GHG mitigation while maintaining productivity. Agriculture contributes to GHG emissions through activities such as rice straw burning, the use of inorganic fertilizers, and fossil fuel consumption. Mitigating global warming through the agricultural sector can be achieved through carbon absorption and sequestration or natural carbon exchange between the atmosphere, oceans, and land. However, this exchange pattern has been altered due to human activities and land use changes. Alterations in land use will modify carbon reserves in the soil. In addition to environmental impacts, the phenomenon of climate change also affects the emergence of vulnerable groups dependent on agriculture for livelihoods (Adib, 2014).

Agricultural problems in Indonesia include: 1) aging farmers due to low regeneration in the agricultural sector, 2) low quality of farmer resources as most farmers have only primary education, 3) the use of conventional technology in most of Indonesian agriculture, 4) limited agro-industry processed products, 5) most agricultural products exported are still raw materials, resulting in limited added value, making the benefits are mostly enjoyed by importing (developed) countries, and 6) the contribution of innovation to economic growth is still very small compared to the Total Productivity Factor (TPF), with Indonesia's TFP value at only 1%, far below other Asian countries, which reach 14-35%. Consequently, Indonesia must accelerate and transform its technology from natural resources agriculture to agriculture based on smart farming technology (Simarmata, 2019). Moreover, The FAO predicts that by 2050, the world's population will increase to 9.6 billion. This means agricultural production must increase by 70% to meet the needs of such a population (Budiharto, 2019).

Farmers in Bali implement a terraced irrigation system to distribute water for agricultural needs. The irrigation system in Bali is known as subak, a sustainable irrigation system managed by traditional social organizations with Pekaseh as the head of the subak. Subak is a traditional organization that has existed since 882 AD (Purwita and Cantika in Sudarta, 2005). The presence of subak is highly significant for agriculture in Bali as it allows for democratic water distribution and ensures that all farmers have fair access to water. The subak irrigation system is based on the philosophy of Tri Hita Karana, which emphasizes maintaining harmonious relationships with God, nature, and humans. The religious rituals carried out regularly by subak members according to the planting stages at the Pura Subak represent the realization of Parahyangan. Pawongan is manifested through the organization that regulates subak irrigation led by Pekaseh and Ketua Munduk in each area, while palemahan is realized through land or area ownership in each subak.

Agriculture has been the primary economic sector in Bali before the extensive development of the tourism sector. More than 600 hectares of agricultural land have been converted since 2017 to 2020. The reduction in productive agricultural land area due to land conversion has led to a shift towards the tourism sector, which has become the mainstay of the Balinese community. In recent decades, this phenomenon has also impacted the sustainability of the natural subak ecosystem, the declining interest of the younger generation in agriculture, and the decreasing environmental resilience due to climate change (Suarjana, 2023). Subak in Bali now coexists with the rapid population growth and urban development. Besides the pressure from tourism needs, subak adjacent to urban areas has its own challenges, such as the geographical condition of flat land, which hampers optimal water distribution for agricultural productivity. The increasingly tangible threat to urban subak farmers is crop failure due to water shortages, ultimately leading landowners to sell their rice fields. A paradigm of development and management of irrigation that focuses solely on physical construction without improving the quality of its managers will lead to disparities (Arif

et al., 2014). Therefore, technological innovation in irrigation plays a crucial role in the well-being of farmers in the era of climate change (Trinugroho, 2023).

The mitigation strategy implemented by Pertamina AFT Ngurah Rai involves the development of low-emission technology to accommodate water needs for agricultural productivity in Subak Sembung, Denpasar City. Water use efficiency in agricultural land can be optimized through the use of appropriate irrigation techniques (Haryati et al., 2011). Pertamina Patra Niaga AFT Ngurah Rai, together with Subak Head Pekaseh and Munduk Palak farmer members, developed the Sustainable Irrigation Management Uma Palak (SIUMA). By adapting the automated avtur distribution technology system at Pertamina Patra Niaga AFT Ngurah Rai, SIUMA becomes a hybrid technology that utilizes renewable energy sources such as solar heat with solar panels and kinetic energy from water using water wheels. The energy supply obtained is then used to supply water to rice fields vulnerable to drought. SIUMA is further adapted by farmers to address climate change, ensuring the sustainability of subak.

B. METHOD

In implementing its empowerment program, Pertamina Patra Niaga AFT Ngurah Rai adopts a community-based empowerment approach. Community-based development is part of a broader paradigm shift in response to well-documented criticisms of top-down, modernist, and authoritarian approaches dominating development policies (Dasgupta & Beard, V. A, 2007). According to World Bank criteria (Resnawati, 2018), the implementation of the Uma Palak Lestari program meets the characteristics of empowerment implementation, such as (1) involving the community as representatives, and serving as the driving force and agents of society. The presence of local heroes serves as the main basis for these agents to sustainably influence other communities. (2) The program operates bottom-up, starting from the planning process, resource management, and implementation, to monitoring and evaluation. This means that the beneficiary communities are the entire subjects of the program, receiving its benefits wholly.

A study was conducted on the Uma Palak Lestari program located on Ahmad Yani Street, Peguyangan Traditional Village, Peguyangan Sub-district, North Denpasar District, Denpasar City, Bali, from January to April 2024. This program is a corporate social responsibility program of PT Pertamina Patra Niaga Aviation Fuel Terminal Ngurah Rai. The data used in this research are primary and secondary. Data collection was carried out through direct interviews using structured question guidelines and from relevant literature. Respondents were purposively selected, including group officials and members, community leaders, and relevant government officials.

C. RESULT AND DISCUSSION

Efforts in development involving all stakeholders from various sectors, including businesses or corporations, have been widely advocated by various parties, including global organizations. The United Nations Conference on Sustainable Development, Rio+20, under the theme "The Future We Want" in June 2012, conveyed that active participation from the private sector can contribute to the achievement of Sustainable Development Goals (SDGs). Subsequently, the United Nations Development Programme (UNDP) presented several reasons why closer collaboration with the private sector is necessary, including its role in driving economic growth, innovating new technologies, and catalyzing social investment and philanthropic resources towards development. Furthermore, the business sector must contribute to the attainment of the Sustainable Development Goals (SDGs) considering social, economic, and environmental aspects. Therefore, Corporate Social Responsibility (CSR) represents the initial step in which the private sector can contribute to SDGs (Arifin, 2022).

In Indonesia, the obligation to implement CSR is regulated by Law No. 40 of 2007 concerning Limited Liability Companies and Government Regulation No. 47 of 2012 concerning Corporate Social Responsibility and Environmental Responsibility of Limited Liability Companies. According to these regulations, social and environmental responsibility is a form of commitment for companies to participate in sustainable economic development and improve the quality of life for both internal and external stakeholders, surrounding communities, and society at large (Parnoto, 2014).

To fulfill the mandate of Law No. 40 of 2007 and Government Regulation No. 47 of 2012, Limited Liability Companies, including State-Owned Enterprises (SOEs) in Indonesia, implement Corporate Social Responsibility (CSR) programs in the areas surrounding their business operations. CSR is the commitment of companies or the business community to the development and economic growth of society as a form of moral responsibility to society and the environment. CSR programs are aimed at encouraging business actors, both in the industrial sector and corporations, to participate in healthy economic growth while considering environmental factors (Siregar & Chairil, 2013).

Pertamina AFT Ngurah Rai is a business unit of PT. Pertamina (Persero) located within the Aviation Business Unit in the Jatimbalinus area, built in 1990/1991 and operational since 1992. It operates 24 hours a day, distributing Aviation Fuel (BBMP) in the form of avtur and avgas for civilian and military aircraft operating at Ngurah Rai International Airport, Bali. As a subsidiary of a SOE, Pertamina Patra Niaga AFT Ngurah Rai has fulfilled its social and environmental responsibilities to the community, focusing on various fields such as social, economic, and environmental aspects. One of the programs that integrates economic improvement objectives with environmental preservation without compromising the noble values of Balinese society is the Sustainable Uma Palak program. This program empowers farmers in Munduk Palak Subak Sembung and develops tourism in subak agricultural areas. Through this program, the SIUMA innovation emerged as an effort to assist farmers in facing the challenges of climate change and the threat of land use change due to unproductive agricultural land.

Subak is an institution/organization formed by farmers in Bali specifically to regulate the traditional irrigation system based on the manifestation of the Tri Hita Karana concept. Subak requires a significant amount of funds for the repair and maintenance of its facilities (Windia, 2006). It is divided into several "munduks" which help facilitate the process of water distribution to all areas of farmers' rice fields. Munduk itself is a sub-group of water distribution within the farmers' internal structure, consisting of smaller numbers. Subak management is led by a pekaseh as the subak chairperson, who will then organize subak meetings based on deliberation for consensus. Additionally, under the leadership of the pekaseh, there are kelian, kesinoman, and krama (subak members). The analytical unit in this research is located in Munduk Palak, which is part of the Sembung subak irrigation system located in the Peguyangan Village, North Denpasar District, Denpasar City, Bali Province. The Munduk Palak area is part of the Uma Palak Lestari program development area, covering an area of 12 hectares and consisting of approximately 40 farmers. The Uma Palak Lestari program is an empowerment program for Munduk Palak farmer groups initiated by PT Pertamina Patra Niaga AFT Ngurah Rai. Group commitment to adopting technology is a key determinant of the success of such innovation adoption (Adawiyah, 2018). Besides that, knowledge, attitudes, the role of farmer groups, and skills significantly influence farmers' willingness to adopt smart farming (Asnamawati et al., 2020).

This CSR program is called Uma Palak Lestari, where “uma” comes from the Balinese language meaning rice fields, “palak” is the name of the munduk, and munduk is a smaller division within subak that functions as a grouping for water distribution. The name of the munduk where this CSR activity takes place is Munduk Palak, while “Lestari” is an Indonesian word meaning remaining as it was, eternal, and sustainable, thus “Lestari” is a prayer offered to the god of the universe. Therefore, the name of this CSR program is nothing but a prayer for the rice fields in Munduk Palak to remain sustainable.

As time passes, with massive urban development, the subak rice field areas are shrinking. Consequently, land use conversion will lead to the loss of cultural values and ultimately cause the subak community to neglect the “parahiyangan.” North Denpasar District experienced land use conversion covering an area of 981.92 hectares from 1992 to 2015 (Trigunasih, 2015). In addition, the phenomenon of climate change causes unpredictable rainy seasons with prolonged dry seasons, which adversely affect subak farmers' sustainability. As a result, there are droughts in rice field areas. This can trigger pathological behavior among subak farmers, resulting in increased intensity of conflicts of interest regarding water distribution for irrigation. The long-term impact of agricultural land narrowing exacerbated by the climate crisis phenomenon leads to vulnerability in food security for farmers and the wider community.

Alongside the rapid changes of the times, subak farmers must be able to adapt to cultivate agricultural areas amidst the hustle and bustle of urban areas. Preserving the increasingly eroded subak cultural traditions is a challenge in itself. Moreover, geographically, the subak agricultural area in Munduk Palak has contours that are not too flat, so some rice field points downstream have difficulty obtaining irrigation water supply. When the harvest season arrives, farmers do not need water, but in some points of the rice field, there is an overflow of water. Meanwhile, during the planting season when farmers should get abundant irrigation water, some points downstream lack water to the point of drought. This anomaly in irrigation water distribution causes some subak farmers to experience crop failures and even pest infestation due to late planting seasons.

In response to the concerns of farmers in Munduk Palak, PT Pertamina Patra Niaga AFT Ngurah Rai took the initiative to develop an innovation titled SIUMA, in collaboration with the farmers of Munduk Palak. SIUMA, which stands for “Suplai Irigasi Manajemen Pertanian Uma Palak” (Uma Palak Agricultural Irrigation Management Supply), is an automated agricultural irrigation system that can be managed and controlled remotely by farmers via the website siumapalak.com. The website offers comprehensive features, including the ability to monitor the moisture levels of the rice fields. When the moisture indicators show that certain areas are dry, the SIUMA website sends notifications about the low moisture conditions at those specific points.

These notifications are received by the SIUMA operator, who then informs other Munduk Palak farmers to collectively agree that the fields showing signs of drought will be irrigated. Farmers who are currently using the irrigation channels for their fields will temporarily close them. The “operator” accounts on SIUMA are held by all Munduk Palak farmers. This SIUMA innovation was developed using waste hose reels from the company, which were then repurposed into micro-hydro waterwheels capable of generating kinetic energy, combined with the use of solar panels as a supplementary component to supply electrical energy from solar power. The SIUMA system was created as an alternative solution to assist Munduk Palak farmers in responding to the climate crisis and addressing the uneven distribution of agricultural irrigation. The operational illustration of the SIUMA system is as follows:

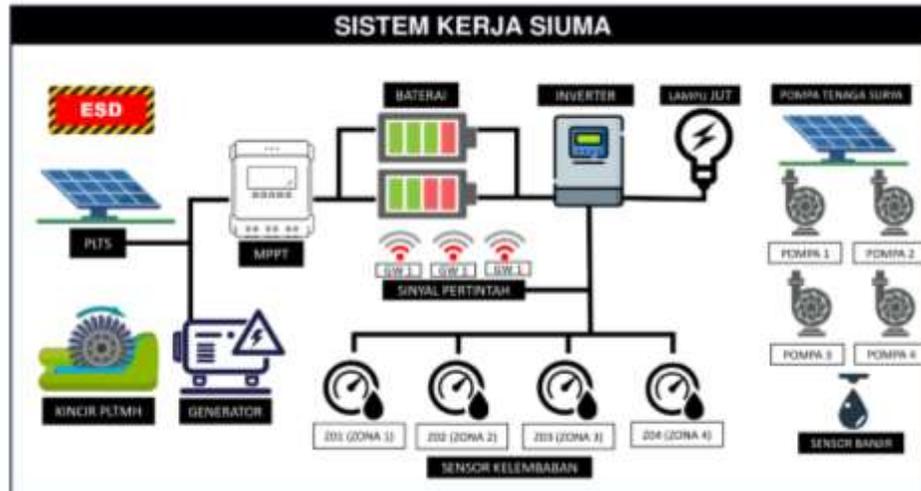


Figure 1. SIUMA Work System
Source: Internal Corporate Data, 2023

The implementation of SIUMA technology marks a novel advancement in agriculture in Denpasar City. The electricity generated from hybrid sources, namely micro-hydro power plants (PLTMH) and solar power plants (PLTS), is sufficient to meet the energy needs of agricultural irrigation pumps and street lighting along the jogging track (Jalan Usaha Tani) with 18 units spanning approximately 420 meters. Additionally, the generated electricity supplies power to oil moisture sensors at seven points, IoT devices installed in the PLTMH area, on/off control of PLTS pumps at four points, and a charging station for jogging track visitors.

The integration of SIUMA technology into the Uma Palak Lestari Program has accelerated the subak irrigation system in Munduk Palak, enhancing both management and benefits for farmers. This technology has also introduced a new paradigm of subak management, transforming it into a sustainable ecotourism area. This is evidenced by the development of Munduk Palak into a tourist destination, offering various recreational spots such as rest areas, jogging tracks, camping grounds, fishing ponds, learning pavilions, maggot farming, stingless bee farming, and the SIUMA system. Consequently, farmers have experienced positive economic impacts, gaining additional income from activities beyond agriculture. Furthermore, the assurance of adequate agricultural irrigation water provided by the SIUMA technology in the Munduk Palak area has significantly benefited farmers. They have become more determined to preserve the subak agriculture in Munduk Palak, preventing the conversion of agricultural land into residential areas in Denpasar City. This effort aims to maintain the sustainability of subak for future generations. The direct beneficiaries of the Uma Palak Lestari Program total 53 individuals, including Munduk Palak farmers, Pekaseh Subak Sembung, KUB Uma Palak, MSME operators along the jogging track, and rest area managers.

D. CONCLUSION

The Uma Palak Lestari Program has successfully created a crucial innovation to support farmers in Munduk Palak, North Denpasar, through the Uma Palak Agricultural Irrigation Management Supply (SIUMA) technology. This program not only assists farmers in addressing the challenges of climate change and land conversion but also promotes ecotourism development, thereby boosting the local economy. SIUMA is a hybrid renewable energy technology that combines solar energy from panels and kinetic water energy from waterwheels to generate



electricity for the automated irrigation system. This technology enables farmers to manage irrigation more efficiently and combat the frequent drought issues in their region. Through a remote management system accessible via the website siumapalak.com, farmers can monitor soil moisture and receive notifications if any areas lack water, ensuring fair and equitable water distribution across the agricultural fields.

This program stems from the urgent need to address the challenges posed by land conversion, which threatens the sustainability of subak within Bali's traditional irrigation system that heavily relies on equitable water distribution. Land conversion from agricultural to non-agricultural uses is increasing in Denpasar due to urbanization and economic growth, resulting in the shrinking of agricultural land and endangering the subak system. According to BPS data (2021), national rice field conversion ranges from 60,000 to 80,000 hectares per year, with significant potential loss in rice yield. Additionally, climate change, causing unpredictable seasons, threatens agricultural production and national food security. SIUMA offers a solution to enhance agricultural productivity amidst climate change challenges. This innovation enables the use of renewable energy to support irrigation, allowing farmers to continue cultivating their land even during prolonged dry seasons. The implementation of SIUMA also aligns with the Tri Hita Karana principle, harmonizing the relationships between humans, nature, and God in Balinese agricultural practices.

The Uma Palak Lestari Program, in addition to focusing on the SIUMA technology, also develops agricultural areas into agritourism destinations. This initiative opens up circular economic opportunities in the agriculture and tourism sectors, providing additional income sources for farmers and the surrounding community. The Uma Palak Lestari ecotourism area attracts many visitors with facilities such as rest areas, jogging tracks, camping grounds, fishing ponds, and maggot and stingless bee farming activities, thereby significantly enhancing the local economy. Farmers are not solely dependent on agricultural yields but also earn income from sustainable tourism activities

The implementation of this program is supported by local policies that ensure the sustainability and strengthening of the subak irrigation system within the city. The community-based empowerment approach adopted by Pertamina Patra Niaga AFT Ngurah Rai involves all stakeholders, including farmers, government, and the community, in every stage of planning, management, and evaluation of the program. This approach ensures that the program is not only top-down but also bottom-up, giving a voice and significant role to the beneficiary community.

The success of the Uma Palak Lestari program and SIUMA technology demonstrates how innovation and collaboration can help farmers face the challenges of climate change and urbanization. With adaptive technology and strong policy support, urban agriculture can develop into a productive and sustainable sector. This program proves that through collaboration between companies, governments, and communities, agricultural sustainability and local economic improvement can be achieved, providing a replicable model for other regions. The SIUMA innovation in the Uma Palak Lestari program not only serves as a survival guide for farmers amid the climate crisis but also opens up circular economic access in the agricultural sector, meets the need for new renewable energy, and supports the sustainability of the subak culture in Bali. This initiative underscores the importance of a holistic approach involving technology, policy, and community empowerment to achieve sustainable and prosperous agriculture.

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