

# Innovative climate resilient indigenous food system combining “Water Taro, Shrimp, Eel and Water Cress in Vanuatu – Scaling Up”

## Vanautu: un sistema alimentario tradicional, innovador y resiliente ante el cambio climático

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### ABSTRACT

Vanuatu, an archipelagic nation in the South Pacific, faces significant challenges due to climate change, including rising sea levels, increased frequency and intensity of natural disasters, and threats to food security. The integration of four components of the food system creates a symbiotic relationship that enhances the overall productivity and sustainability.

Key challenges faced in implementing this integrated food system include limited access to knowledge and resources, the need for community participation and capacity building, and the potential impacts of natural disasters. To address these challenges, the project has employed various solutions, such as providing training and technical support to farmers, establishing community organizations, and developing disaster risk management plans.

The integrated food system has achieved significant results and impacts, including increased crop yields, improved food security, and greater resilience to climate change. Farmers have reported higher incomes and improved livelihoods, while the local environment has benefited from the sustainable land management practices employed.

In conclusion, the integration of water taro, shrimp, eels, and watercress in Vanuatu demonstrates the potential of innovative and climate-resilient indigenous food systems to improve food security and resilience to climate change. The success of this system underscores the importance of collaboration, community participation, and the integration of traditional knowledge with modern sustainable land management practices. By scaling up this approach, Vanuatu and other nations can work towards building more resilient and sustainable food systems for the future.

### PALABRAS CLAVE

Sistema alimentario autóctono

Resistencia al cambio climático

Vanuatu

Ampliación

Innovación

GIHAS

### RESUMEN

Vanuatu, una nación archipiélago en el Pacífico Sur, enfrenta desafíos significativos debido al cambio climático, como el aumento del nivel del mar, la mayor frecuencia e intensidad de desastres naturales y las amenazas a la seguridad alimentaria. La integración de cuatro componentes del sistema alimentario crea una relación simbiótica que mejora la productividad y sostenibilidad.

Los principales desafíos en la implementación de este sistema alimentario integrado incluyen el acceso limitado al conocimiento y los recursos, la necesidad de participación comunitaria y desarrollo de capacidades, y los impactos potenciales de los desastres naturales. Para abordar estos desafíos, el proyecto ha implementado soluciones como la capacitación y el apoyo técnico a los agricultores, la creación de organizaciones comunitarias y el desarrollo de planes de gestión de riesgos de desastres.

El sistema alimentario integrado ha logrado resultados e impactos significativos, como el aumento en los rendimientos de los cultivos, la mejora de la seguridad alimentaria y una mayor resiliencia al cambio climático. Los agricultores han reportado mayores ingresos y mejores medios de vida, mientras que el medio ambiente local se ha beneficiado de las prácticas sostenibles de manejo de la tierra.

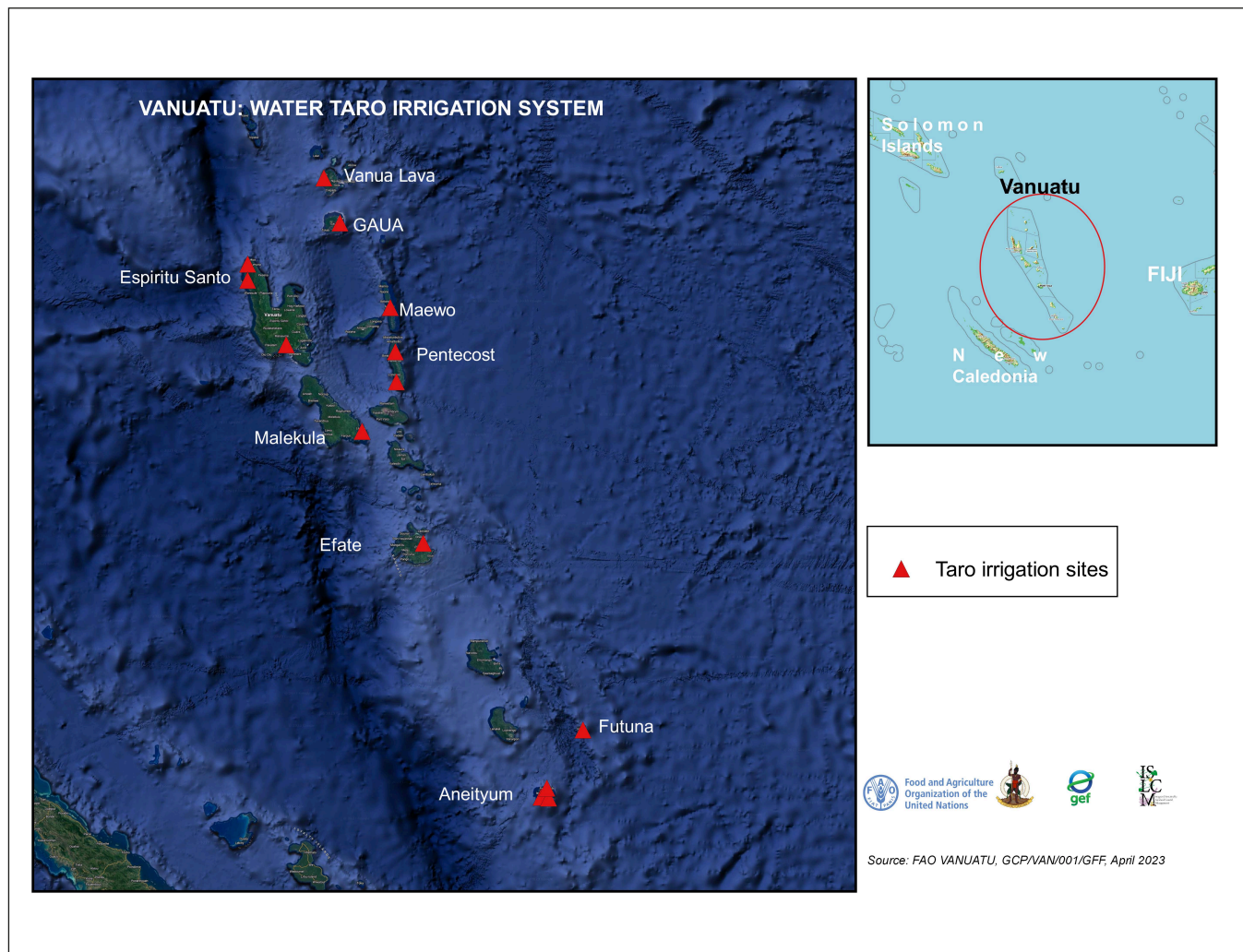


En conclusión, la integración de taro acuático, camarones, anguilas y berros en Vanuatu demuestra el potencial de los sistemas alimentarios indígenas innovadores y resistentes al clima para mejorar la seguridad alimentaria y la resiliencia frente al cambio climático. El éxito de este sistema subraya la importancia de la colaboración, la participación comunitaria y la integración del conocimiento tradicional con prácticas modernas de manejo sostenible de la tierra. Al ampliar este enfoque, Vanuatu y otras naciones pueden trabajar hacia la construcción de sistemas alimentarios más resilientes y sostenibles para el futuro.

## 1. INTRODUCTION

Vanuatu (figure 1), an island nation in the Pacific, faces significant challenges due to its vulnerability to climate change. The country's food security is particularly at risk, as traditional agricultural practices are increasingly threatened by extreme weather events and rising sea levels. In response to these challenges, innovative and climate-resilient food systems are urgently needed.

This paper focuses on a unique and promising indigenous food system in Vanuatu (FAO, 2023) that combines the cultivation of water taro, shrimp, eel, and watercress. This system has been practiced for generations and demonstrates remarkable resilience in the face of climate change. By integrating these four elements, the system provides a diverse and nutritious food source while also promoting environmental sustainability.



**Figure 1.** Vanuatu and islands part of research. Source: ISLCM Project.GIS Department 2023. Own elaboration.



Water taro (Gleick, 2018), a staple crop in Vanuatu, is well-adapted to the island's tropical climate and can withstand periods of flooding and drought. The plant grows in waterlogged conditions, making it an ideal crop for low-lying areas prone to sea-level rise. Additionally, water taro is highly nutritious, providing a rich source of carbohydrates, fiber, and essential vitamins and minerals.

Shrimp and eel are also integral components of this indigenous food system. These aquatic species are raised in the same water-logged environment as the water taro, creating a symbiotic relationship that enhances the overall productivity and resilience of the system. Shrimp and eel not only provide a valuable source of protein but also contribute to the nutrient cycling within the system, enriching the water and soil with their waste products.

Watercress, a fast-growing aquatic plant, is another key element of this food system. It thrives in the nutrient-rich water and provides a highly nutritious green vegetable that is rich in vitamins A, C, and K, as well as minerals such as calcium and iron. Watercress also acts as a natural filter, helping to maintain water quality and prevent the buildup of harmful pollutants (FAO, 2021).

The integration (FAO, 2023) of these four elements – water taro, shrimp, eel, and watercress – creates a highly efficient and sustainable food system that is well-suited to Vanuatu's unique environmental conditions. By mimicking natural ecosystems, this system minimizes waste and optimizes resource use, reducing the need for external inputs such as fertilizers and pesticides.

Moreover, this indigenous food system is deeply rooted in Vanuatu's cultural heritage and traditional knowledge. For generations, local communities have developed and refined these practices, passing down their expertise from one generation to the next. This traditional knowledge is invaluable in the face of climate change, as it provides a foundation for adapting to new challenges and developing innovative solutions.

However, despite its many benefits, this indigenous food system is under threat from a range of factors, including land-use change, population growth, and the increasing frequency and severity of extreme weather events. To ensure the long-term viability of this system (UNDP, 2020), it is essential to support and strengthen local communities' capacity to maintain and adapt their traditional practices.

This can be achieved through a range of interventions, such as providing technical assistance and training, promoting the value of traditional knowledge, and developing policies and programs (UNU-EUS, 2021) that support the conservation and sustainable use of indigenous food systems. By working closely with local communities and building on their existing knowledge and practices, it is possible to develop resilient and sustainable food systems that can withstand the impacts of climate change.

In conclusion, the indigenous food system in Vanuatu that combines water taro, shrimp, eel, and watercress offers a promising model for climate-resilient agriculture in the face of growing environmental challenges. By integrating traditional knowledge with modern scientific understanding, this system demonstrates the potential for developing sustainable and nutritious food sources that are well-adapted to local conditions. As the world seeks to address the urgent challenges posed by climate change, it is essential to recognize and support the value of indigenous food systems and the communities that maintain them.

## 1.1. Context and background

The integrated taro irrigation system in Vanuatu stands as a testament to the ingenuity and resilience of indigenous agricultural practices (SPREP, 2021). This system, deeply rooted in the cultural fabric of vanuatuan society, is a sophisticated interplay between ecology (Altieri, 2018) and sustenance, harnessing the natural landscape to cultivate *Colocasia esculenta*, commonly known as water taro. Passed down through generations, this traditional method has not only provided a stable food source but also embodies the adaptive strategies of a community living in harmony with its environment.

In the face of modern challenges, particularly those posed by climate change and environmental degradation, the significance of such system has become increasingly pronounced. The forests of Vanuatu, integral to maintaining the water levels necessary for taro cultivation, have suffered from deforestation and unsustainable land use practices. Recognizing this, there has been a national shift towards environmental



protection and climate-resilient agriculture, with the integrated taro irrigation system at the heart of this movement.

The FAO-GEF project “Integrated Sustainable Land and Coastal Management”(2021-2023) in Vanuatu is a strategic initiative aimed at bolstering these efforts. By integrating sustainable land management practices with coastal area protection, the project seeks to enhance the resilience of both ecosystems and local communities. This approach aligns with several Sustainable Development Goals (SDGs), including responsible land use, food security, and biodiversity conservation.

Presently, an extensive review involving documentation analysis, field visits, and GIS mapping has revealed that over six thousand households rely on the Water Taro Gardens. These gardens not only sustain a significant portion of the population but also hold potential for expansion and increased productivity. The taro fields are sustained by a delicate balance of water levels, necessitating ongoing forest conservation to maintain their recharge function. These forests serve multiple purposes: providing firewood, construction materials, and medicinal plants to local communities while simultaneously supporting a rich biodiversity that includes rare species of flora and fauna.

Moreover, the taro irrigation system is interwoven with cultural heritage sites that reflect the historical evolution of these agricultural practices. These sites are sacred spaces where communities connect with their spiritual traditions, further emphasizing the cultural dimensions of this agricultural system.

The integrated taro irrigation system in Vanuatu is a paragon of sustainable (Altieri, 2018) agriculture that encapsulates food security, environmental stewardship, cultural preservation, and community empowerment. The GIAHS designation would not merely recognize its historical significance but would also safeguard its future, reinforcing the livelihoods that are intricately connected to this unique agricultural heritage.

Therefore, Vanuatu’s integrated taro irrigation system is a remarkable blend of tradition and sustainability. Its recognition and conservation are imperative for ensuring that this indigenous knowledge system, which has supported generations, continues to thrive in an era marked by ecological uncertainties. Through initiatives like the FAO-GEF project and potential GIAHS designation, there is hope for these ancient practices to endure as beacons of resilience in a changing world.

## 2. METHODOLOGY

### 2.1. Key problem(s) addressed

The innovative water taro gardens in Vanuatu, supported by the FAO-GEF project Integrated Sustainable Land and Coastal Management in Vanuatu, address several key problems that affect the productivity and sustainability of traditional agricultural practices. This project aims to promote sustainable land and coastal management practices, including the development of climate-resilient agricultural systems.

One of the primary problems addressed by the water taro gardens is limited water availability. During dry seasons, water scarcity significantly impacts the growth and yield of taro plants, which are a staple crop in Vanuatu. To combat this issue, innovative solutions such as irrigation systems, rainwater harvesting techniques, and water-efficient farming practices have been implemented to ensure a consistent water supply throughout the year. These measures not only improve crop yields but also contribute to climate change adaptation by enhancing resilience to drought conditions.

Soil erosion (UNPD, 2020) is another critical problem that the water taro gardens tackle. Taro gardens are often located on steep slopes, making them prone to soil erosion during heavy rains. To mitigate this issue, contour farming techniques, terracing, and the use of cover crops have been adopted. These practices help stabilize the soil, reduce erosion risks, and prevent the loss of valuable topsoil, which is essential for maintaining soil fertility and productivity.

Improving the quality and quantity of taro produced is crucial for enhancing food security and income generation in Vanuatu. The FAO-GEF project has introduced improved taro varieties that are resistant to pests





and diseases, ensuring higher yields and better crop quality. Additionally, good agricultural practices such as crop rotation, proper fertilization, and weed control have been implemented to optimize crop production while promoting sustainable farming methods.

The water taro gardens also contribute to biodiversity conservation by incorporating agroforestry practices (Thaman, 2020). These practices involve integrating trees and shrubs into the farming system, providing shade, windbreaks, and habitat for various plant and animal species. This approach not only enhances ecosystem services but also supports the preservation of Vanuatu's rich biodiversity.

Furthermore, the project emphasizes capacity building and knowledge sharing among local communities. Farmers are trained in sustainable agricultural techniques, water management strategies, and climate-resilient practices. This empowers them to adapt to changing environmental conditions and ensures the long-term sustainability of the water taro gardens.

By addressing these key problems through innovative solutions, the FAO-GEF project Integrated Sustainable Land and Coastal Management in Vanuatu aims to improve food security, enhance climate resilience, and promote sustainable land and coastal management practices. The water taro gardens serve as a model for integrating traditional knowledge with modern agricultural techniques, ensuring a balance between environmental conservation and economic development.

## 2.2. Technological or innovative solutions employed

Vanuatu has embraced various technological and innovative solutions to improve water taro gardens, ensuring sustainable and efficient agricultural practices. These solutions have been implemented to address the challenges faced by farmers, such as water scarcity, pest infestations, and the need for sustainable energy sources. By adopting these innovative approaches, Vanuatu aims to enhance food security, increase crop yields, and promote environmentally friendly farming methods.

One of the key technological advancements in water taro gardens is the improvement of dike construction. Gabion dams, which are structures made of wire cages filled with rocks, have been introduced to enhance water management. These dams help to control water flow, prevent soil erosion, and ensure an adequate water supply for the taro plants. Additionally, water diversion systems have been optimized to efficiently distribute water throughout the gardens, minimizing water waste and ensuring that each plant receives the necessary hydration.

To further improve water management and prevent pest infestations, cleaning ditches have been implemented in the taro gardens. These ditches are regularly maintained to remove debris, silt, and potential breeding grounds for insects. Moreover, specific plants have been strategically introduced along the ditches to act as natural barriers against insect infestations. These plants not only help to repel pests but also contribute to the overall biodiversity of the garden ecosystem.

Another innovative solution employed in Vanuatu's water taro gardens is the use of drip irrigation systems. These systems have revolutionized the way water is delivered to the plants, providing a constant and controlled supply of water directly to the roots. By targeting the water delivery, drip irrigation reduces water waste, minimizes the risk of plant diseases, and promotes healthy plant growth. The precise application of water also helps to conserve this precious resource, which is particularly important in regions prone to water scarcity.

Aquaponics, a highly efficient and sustainable farming method, has also been introduced in Vanuatu's water taro gardens. This system combines aquaculture (fish farming) with hydroponics (growing plants without soil). In an aquaponic setup, the waste produced by the fish is rich in nutrients and is used to fertilize the taro plants. In return, the plants act as natural filters, purifying the water for the fish. This symbiotic relationship creates a closed-loop system that minimizes waste and maximizes resource efficiency. Aquaponics has shown remarkable results in terms of taro yields, as the plants benefit from the constant supply of nutrients from the fish waste.



To address the need for sustainable energy sources in water taro gardens, solar-powered pumps have been introduced. These pumps harness the abundant solar energy available in Vanuatu to power the irrigation systems. By using renewable energy, farmers can reduce their reliance on fossil fuels, which not only lowers operational costs but also contributes to environmental sustainability. Solar-powered pumps provide a reliable and eco-friendly alternative to traditional pumping methods, ensuring a consistent water supply even in remote areas without access to electricity grids.

The adoption of these technological and innovative solutions in Vanuatu's water taro gardens has yielded significant benefits for farmers and the community as a whole. Improved water management, pest control, and sustainable energy sources have led to increased crop yields, reduced water waste, and enhanced food security. By embracing these advancements, Vanuatu is setting an example for other Pacific Island nations facing similar agricultural challenges.

Moreover, the implementation of these solutions has not only improved the efficiency and sustainability of water taro gardens but has also created opportunities for knowledge sharing and capacity building among farmers. Through training programs and workshops, farmers can learn about these innovative practices, exchange ideas, and adapt them to their specific contexts. This collaborative approach fosters a sense of community and empowers farmers to take ownership of their agricultural practices.

In conclusion, Vanuatu's embrace of technological and innovative solutions in water taro gardens demonstrates the country's commitment to sustainable agriculture (Altieri, 2018) and food security. By adopting improved dike construction, drip irrigation systems, aquaponics, and solar-powered pumps, Vanuatu is addressing the challenges faced by farmers while promoting environmentally friendly practices. These solutions not only enhance crop yields and resource efficiency but also contribute to the overall resilience of the agricultural sector. As Vanuatu continues to invest in these innovative approaches, it serves as a model for other Pacific Island nations seeking to improve their water taro gardens and ensure a sustainable future for their communities.

### 3. RESULTS

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#### 3.1. Key outcomes

The FAO-GEF project Integrated Sustainable Land and Coastal Management in Vanuatu has been instrumental in promoting innovative solutions for water taro gardens, leading to significant outcomes and measurable impacts. The project has focused on enhancing food security, improving water management practices, building resilience against natural disasters, and preserving cultural heritage.

One of the key outcomes of the project has been the increased production of food and income generation for local communities. Water taro gardens have become a reliable source of sustenance for many households, providing a stable supply of nutritious food. The gardens have also created employment opportunities for farmers and other workers involved in the cultivation, harvesting, and processing of water taro. This has had a positive impact on the local economy, as it has diversified income streams and reduced dependence on imported food products.

The implementation of water taro gardens has also led to improved water management practices in the communities. Through the project, communities have become more aware of the importance of effective water conservation and management. They have learned techniques to reduce water waste, such as using mulch to retain moisture in the soil and implementing efficient irrigation systems. These practices have not only helped to conserve water resources but have also contributed to improved water quality by reducing runoff and erosion.

Another significant outcome of the project has been the demonstrated resilience of water taro against cyclones. Vanuatu is highly vulnerable to natural disasters, particularly cyclones, which can have devastating effects on the country's agriculture and food security. However, water taro has shown remarkable resilience against severe events like Tropical Cyclone Harold in 2020 and Tropical Cyclones Judy and Kevin in 2023.



Despite the destruction caused by these cyclones, water taro gardens have managed to withstand the strong winds and heavy rains, ensuring a continuous supply of food for the affected communities. This resilience has been crucial in facilitating recovery efforts and maintaining food security in the aftermath of disasters.

The water taro gardens have also fostered a sense of solidarity among the islands of Vanuatu. In times of emergency, such as after cyclones, communities have come together to share their resources, including water taro, with those in need. This spirit of cooperation and mutual support has strengthened the social fabric of the communities and enhanced their ability to cope with adversity.

Furthermore, the project has contributed to the preservation of traditional knowledge and practices associated with water taro cultivation. Water taro has been an integral part of Vanuatu's cultural heritage for generations, and the gardens serve as a means of ensuring the transmission of this knowledge to future generations. By engaging young people in the cultivation and management of water taro gardens, the project has helped to bridge the generational gap and maintain the continuity of traditional practices.

In conclusion, the FAO-GEF project Integrated Sustainable Land and Coastal Management in Vanuatu has had a significant impact on the country's food security, water management, disaster resilience, and cultural preservation. The implementation of innovative solutions in water taro gardens has led to increased food production, improved water conservation practices, enhanced resilience against cyclones, and the strengthening of social bonds among communities. These outcomes demonstrate the effectiveness of the project in addressing the challenges faced by Vanuatu and highlight the potential for replicating similar initiatives in other small island developing states facing similar issues.

### 3.2. Key actors and stakeholders involved

The successful implementation and scaling up of innovative climate-resilient indigenous food systems, particularly those integrating water taro, shrimp, eel, and watercress in Vanuatu, hinge on the collaborative efforts of multiple actors and stakeholders. The FAO-GEF project "Integrated Sustainable Land and Coastal Management" serves as a cornerstone for these endeavors, bringing together a diverse array of contributors each playing a pivotal role in nurturing this sustainable agricultural practice.

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- **Government of Vanuatu:** The Government of Vanuatu stands at the forefront of this initiative, providing not only the regulatory framework and policies conducive to environmental stewardship but also channeling funds to fortify the infrastructure underpinning these food systems. By instituting supportive measures and incentives, the government ensures that the water taro gardens are both a viable and attractive option for local farmers, thus fostering a conducive environment for the proliferation of these traditional practices.
- **Farmers and local communities:** At the heart of the water taro gardens are the farmers and local communities whose stewardship and labor breathe life into these systems. These custodians of tradition employ centuries-old knowledge passed down through generations to cultivate the land. Their hands-on approach ensures the vitality and productivity of the gardens, while their intimate understanding of local ecosystems allows for adaptive management in the face of climatic uncertainties. Moreover, these communities serve as vital conduits for knowledge exchange, sharing insights and techniques that underpin the resilience of these food systems.
- **Non-Governmental Organizations (NGOs) and international development agencies:** NGOs and international development agencies act as invaluable allies in this agricultural mosaic, offering layers of support that range from technical expertise to financial assistance. These entities collaborate closely with both government bodies and local communities to tailor programs that enhance the capacity of farmers, ensuring that sustainable practices are not only adopted but also maintained over time. Their role often extends beyond mere implementation; they advocate for policy shifts, foster community engagement, and contribute to building a robust framework that underpins the long-term viability of water taro gardens.



- **Researchers and academics:** The scholarly community contributes to this tapestry by delving into the multifaceted aspects of water taro gardens. Through rigorous research, they unearth insights into the ecological, economic, and social benefits these systems offer, while also identifying potential challenges that could impede their success. Academics play a crucial role in fine-tuning cultivation techniques, enhancing pest control measures, and optimizing water usage – all essential components for ensuring the sustainability of these gardens. Their findings not only inform best practices but also help to articulate the value of these systems to policymakers, practitioners, and the global community.
- **Private sector entities:** Private sector involvement introduces innovation and investment into the mix, propelling the modernization of traditional practices. By introducing new technologies such as drip irrigation systems or solar-powered solutions, private companies can help to increase efficiency and reduce labor intensity. Their engagement, often driven by corporate social responsibility initiatives or investment in sustainable agriculture, can lead to scalable models that enhance productivity while maintaining ecological balance.
- **Cultural institutions:** Cultural institutions within Vanuatu play a subtle yet significant role in preserving the intangible heritage that surrounds water taro cultivation. By documenting traditional practices, celebrating local food systems through festivals, and educating the youth about their ancestral agricultural heritage, these institutions help to maintain the cultural fabric that is integral to the identity and continuity of these practices.
- **International bodies:** Lastly, international bodies such as the United Nations play a dual role in both advocating for and providing platforms to share successful models like Vanuatu's water taro gardens on a global stage. By recognizing these systems as repositories of indigenous knowledge and sustainable practices, international organizations can facilitate knowledge transfer across borders, helping similar communities worldwide adapt to their own climate resilience challenges.

In conclusion, the intricate network of actors and stakeholders involved in Vanuatu's water taro gardens exemplifies a collaborative approach to sustainable development. Each stakeholder brings unique strengths and resources to the table, creating a resilient structure capable of withstanding environmental challenges while providing food security and preserving cultural heritage. The FAO-GEF project "Integrated Sustainable Land and Coastal Management" stands as a testament to what can be achieved when diverse groups unite with a common purpose: to scale up innovative climate-resilient indigenous food systems for a sustainable future.

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### 3.3. Challenges encountered and efficiencies gained

The integration of Water Taro Gardens within Vanuatu's indigenous food systems has navigated a complex landscape of challenges and efficiencies. The FAO-GEF project "Integrated Sustainable Land and Coastal Management" has been instrumental in addressing these issues, ensuring the continuity and enhancement of these traditional agricultural practices.

- **Land-use trade-off:** One of the most significant challenges has been managing the trade-off between land allocated for taro cultivation and land required for other economic activities such as tourism and infrastructure development. This delicate balance necessitates comprehensive land-use planning and extensive stakeholder consultation. The project has facilitated a participatory approach to land-use planning, ensuring that taro cultivation remains a priority while accommodating the growth of other sectors vital to Vanuatu's economy.
- **Climate change impact:** The adverse effects of climate change, particularly on water availability and soil fertility, have threatened the sustainability of Water Taro Gardens. The FAO-GEF project has introduced sustainable farming practices such as mulching, composting, and crop rotation, which have not only mitigated these impacts but also led to increased productivity and resilience of the taro





crops. These practices have been tailored to the unique environmental conditions of Malampa, Torba, Sanma, Penama, Shefa, and Tafea provinces, ensuring their effectiveness.

- **Efficiency in water management:** Innovations in water management have been a cornerstone of the project. By adopting techniques such as controlled irrigation and water harvesting, farmers have been able to maintain optimal moisture levels for taro cultivation, despite irregular rainfall patterns. These methods have also reduced water wastage and preserved the quality of waterways, contributing to the overall health of the ecosystem.
- **Pest and disease control:** The project has also tackled the increased incidence of pests and diseases, which are exacerbated by climate change. By promoting integrated pest management (IPM) and the use of natural predators, farmers have successfully protected their crops without relying heavily on chemical pesticides, which can be harmful to the environment.
- **Win-win situations:** The Water Taro Gardens have created multiple win-win scenarios. They have bolstered food security for local communities and provided a sustainable source of income through the sale of taro, shrimp, eel, and watercress. Additionally, these gardens have become a symbol of cultural identity and heritage, preserving traditional knowledge and practices. The aesthetic appeal of the lush taro fields has also attracted tourism, offering a new revenue stream while raising awareness about the importance of conserving indigenous food systems.
- **Cultural preservation:** The FAO-GEF project has recognized the cultural significance of Water Taro Gardens and has worked to ensure that traditional knowledge is passed down to younger generations. Workshops and educational programs have been established to teach the youth about the intricacies of taro cultivation, water management, and the ecological importance of these practices.
- **Biodiversity conservation:** The Water Taro Gardens support a high level of biodiversity, providing habitat for various aquatic and terrestrial species. The FAO-GEF project has emphasized the conservation of these areas as hotspots for biodiversity, contributing to the overall ecological balance and resilience to climate change.

In conclusion, while there have been challenges in maintaining the delicate balance between traditional agricultural practices and modern economic demands, the FAO-GEF project “Integrated Sustainable Land and Coastal Management” has made significant strides in ensuring that Water Taro Gardens continue to thrive in Vanuatu. The project’s success lies in its ability to integrate indigenous knowledge with innovative scientific approaches, creating a resilient food system that benefits both people and the planet.

### 3.4. Factors for success

The thriving water taro gardens in Vanuatu are a testament to the resilience and adaptability of indigenous food systems. Several critical factors contribute to their success, which are enhanced by initiatives such as the FAO-GEF project on Integrated Sustainable Land and Coastal Management. These factors form the backbone of a sustainable agricultural practice that supports food security and livelihoods in the face of climate change.

- **Proper soil preparation:** The foundation of a successful taro garden lies in its soil. In Vanuatu, traditional knowledge passed down through generations emphasizes the importance of preparing the land to ensure it has the right structure and fertility for taro cultivation. This involves the careful selection of land, clearing of vegetation, and the incorporation of organic matter to improve soil health. Meticulous attention to soil conditions ensures that taro plants have a robust start and can thrive even in adverse weather conditions.
- **Adequate irrigation:** Water taro, as its name suggests, requires consistent access to water. The indigenous irrigation systems in Vanuatu, which include both naturally occurring and man-made channels, are critical for maintaining a steady supply of water. These systems demonstrate an intricate



understanding of the landscape and water management that has been refined over centuries. The FAO-GEF project supports these practices by introducing innovative technologies that complement traditional methods, ensuring that water is used efficiently and sustainably.

- **High-quality planting materials:** The success of taro cultivation also hinges on the quality of planting materials. In Vanuatu, farmers select the healthiest and most vigorous taro corms for planting. This selection process is crucial for disease resistance, yield, and the overall quality of the harvest. The FAO-GEF project aids in the dissemination of high-quality planting materials by establishing nurseries and seed banks that preserve and propagate superior taro varieties.
- **Pest and disease management:** Pests and diseases pose a significant threat to taro crops. In response, farmers in Vanuatu employ various traditional and innovative pest management strategies. These include crop rotation, intercropping, and the use of natural predators to control pest populations. The FAO-GEF project further supports these efforts by providing training on integrated pest management techniques that minimize the need for chemical pesticides, thus protecting both the crops and the environment.
- **Effective marketing strategies:** For farmers, cultivating taro is only part of the equation; they must also be able to sell their produce. Effective marketing strategies are essential for connecting farmers with markets and ensuring a fair price for their crops. The FAO-GEF project assists in this regard by helping to establish farmer cooperatives, improve market infrastructure, and facilitate access to information on market trends and prices.
- **Ongoing education and training:** Continuous learning is vital in an ever-changing agricultural landscape. Farmers in Vanuatu benefit from ongoing education and training programs that keep them abreast of the latest agricultural techniques, climate-resilient practices, and sustainable land management strategies. The FAO-GEF project plays a pivotal role in providing such education by organizing workshops, field days, and exchange programs that enable farmers to learn from experts and each other.

In conclusion, the success of water taro gardens in Vanuatu is multifaceted, relying on a combination of traditional knowledge and innovative practices. The FAO-GEF project's integrated approach to sustainable land and coastal management has been instrumental in scaling up these indigenous food systems, ensuring their resilience in the face of environmental challenges while preserving the rich cultural heritage of Vanuatu's people.

### 3.5. Lessons learned (both positive and negative)

The FAO-GEF project "Integrated Sustainable Land and Coastal Management in Vanuatu" has provided valuable insights and lessons learned, both positive and negative, that can inform future projects and initiatives in the region. One of the key components of the project was the establishment and maintenance of water taro gardens, which have yielded several important lessons.

Firstly, the project has highlighted the crucial role of community (table 1) involvement in decision-making processes and the integration of traditional knowledge in promoting sustainable agricultural practices. By actively engaging local communities and respecting their traditional practices, the project has fostered a sense of ownership and responsibility among the participants. This approach has led to increased adoption of sustainable farming techniques and has contributed to the overall success of the water taro gardens. The lesson learned here is that projects aiming to promote sustainable agriculture should prioritize community participation and value the wealth of knowledge and experience that local communities possess.

**Table 1.** Number of House Holds and Beneficiaries involved 2023.

Locations	Households	Inhabitants	Women	Men
West Vanua Lava	331	1,820	819	1,001
Gaua	484	2,240	1,008	1,232
Maewo	360	1,980	891	1,089
South Santo	1042	5,210	2,344	2,865
West-N.Santo	1003	5,516	2,482	3,033
N.Efate	628	3,140	1,413	1,727
Futuna	103	515	237	278
Aneityum	310	1,550	682	868
S.Pentecost	1170	6,201	3,410	2,790
Maskelyn	856	3,424	1,541	1,883
Total	6,287	31,596	14,827	16,716

Source: ISLCM Project.2021-2023. Own elaboration.

However, the project has also underscored the vulnerability of small island communities to the impacts of climate change. Vanuatu, like many other Pacific Island nations, is particularly susceptible to rising sea levels, increased frequency and intensity of extreme weather events, and changes in rainfall patterns. These climate-related challenges pose significant risks to the sustainability of water taro gardens and other agricultural activities. The project has emphasized the need for income diversification strategies to build resilience among local communities. By promoting alternative livelihood options, such as agroforestry (Thaman, 2020), aquaculture, and eco-tourism, the project aims to reduce the reliance on a single crop or activity, thereby mitigating the potential impacts of climate change. This lesson highlights the importance of adopting a holistic approach to sustainable development, one that considers the complex interplay between environmental, social, and economic factors.

Another key lesson learned from the project is the importance of ongoing research and collaboration with local communities. While the water taro gardens have shown promising results, there is still a need for further research to optimize the production systems, improve water management practices, and identify the most suitable taro varieties for different environmental conditions. Collaborative research efforts involving local farmers, extension officers, and scientific experts can help bridge the gap between traditional knowledge and modern agricultural science. By fostering a participatory research approach, the project can ensure that the solutions developed are not only scientifically sound but also culturally appropriate and socially acceptable. This lesson emphasizes the value of continuous learning, adaptation, and innovation in the face of evolving challenges (table 2).

On the negative side, the project has also encountered some challenges that provide valuable lessons for future initiatives. One such challenge has been the limited access to markets for water taro products. While the project has successfully increased taro production, the lack of reliable market linkages has hindered the ability of farmers to generate sustainable income from their crops. This lesson underscores the need for a comprehensive value chain approach that not only focuses on production but also addresses issues related to processing, storage, transportation, and marketing. Future projects should prioritize the development of robust market linkages and support the establishment of local agro-enterprises to ensure the long-term economic viability of sustainable agricultural practices.

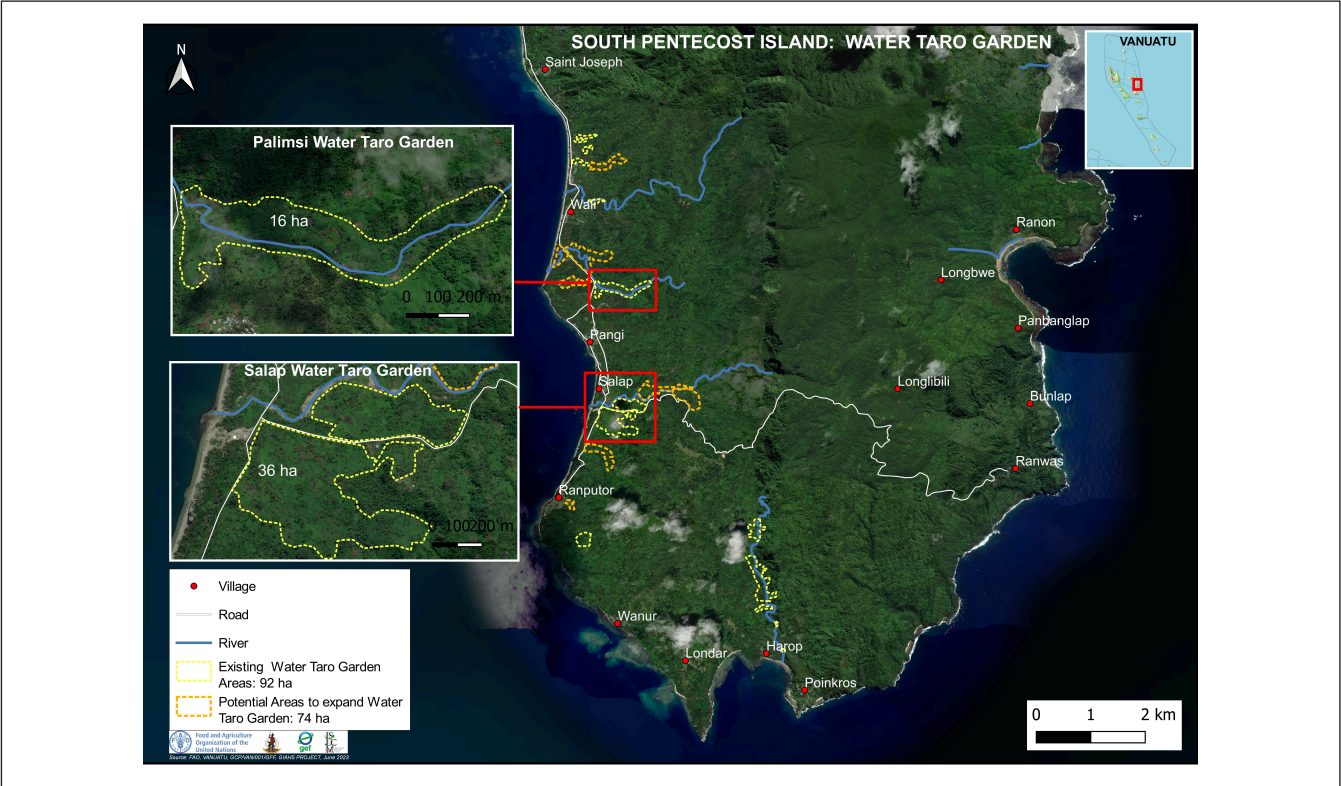


**Table 2.** Number of Hectares under cultivation and potential 2023 Ha.

Locations	Existing (ha)	Potential (ha)	Total (ha)
West Vanua Lava	45	194	239
Gaua	7	30	37
Maewo	169	114	283
South Santo	10	13	23
West-N.Santo	127	483	610
N.Efate	2	38	40
Futuna	13	30	43
Aneityum	10	45	55
S.Pentecost	26	56	82
Maskelyn	10	30	40
Total	419	1,033	1,452

Source: ISCM Project survey.2021-2023. Own elaboration.

Another negative lesson learned relates to the limited capacity of local institutions to provide ongoing technical support and extension services to farmers. While the project has provided initial training and capacity building, the sustainability of these efforts relies on the ability of local institutions to continue providing support beyond the project’s lifespan. This lesson highlights the need for strengthening the capacity of local government agencies, NGOs, and community-based organizations to deliver effective and sustainable extension services. Future projects should invest in institutional capacity building and explore innovative approaches, such as farmer-to-farmer extension and the use of digital technologies, to ensure the continuity of support to local communities (figure 2).



**Figure 2.** South Pentecost. Current situation and potential enlargement WTG, 2023. Source: own elaboration based on ISLCM.





In conclusion, the FAO-GEF project “Integrated Sustainable Land and Coastal Management in Vanuatu” has provided valuable lessons learned, both positive and negative, that can guide future efforts to promote sustainable agriculture and build resilience in small island communities. By prioritizing community involvement, recognizing the vulnerability to climate change, fostering collaborative research, developing market linkages, and strengthening local institutional capacity, future projects can build upon the successes and address the challenges encountered in Vanuatu. These lessons serve as a reminder of the complexity and multifaceted nature of sustainable development and the importance of continuous learning and adaptation in the face of evolving challenges.

## 4. DISCUSSION

### 4.1. Relevance of water taro gardens in climate-resilient agriculture

The FAO-GEF project “Integrated Sustainable Land and Coastal Management in Vanuatu” addresses the pressing challenges posed by climate change, promoting sustainable practices that are crucial for the resilience of agrifood systems. Water taro gardens, as a component of this project, offer a multifaceted approach to climate action, aligning with global sustainability goals.

#### 4.1.1. Climate action and environmental impact

Water taro gardens contribute significantly to climate action by reducing greenhouse gas emissions through sustainable agricultural practices. Utilizing renewable energy sources, such as solar power for irrigation, and implementing efficient water management techniques like drip irrigation, taro growers can minimize their carbon footprint. These practices not only conserve water but also ensure optimal plant growth, reducing waste and enhancing resource efficiency (Smith *et al.*, 2020).

Moreover, water taro gardens enhance carbon sequestration. Taro plants capture atmospheric carbon dioxide, storing it in their biomass and soil. Sustainable practices such as cover cropping, mulching, and composting further increase soil carbon content, contributing to climate change mitigation (Lal, 2019). These methods improve soil health, reduce erosion, and maintain soil moisture, creating a resilient agricultural ecosystem.

#### 4.1.2. Water resource management

The dependency of water taro gardens on clean water sources highlights the importance of water conservation measures. Techniques like rainwater harvesting and watershed management are vital in mitigating the impacts of climate change, such as droughts and floods. These practices ensure a reliable water supply, protect ecosystems, and support community resilience (Gleick, 2018).

#### 4.1.3. Biodiversity and agrobiodiversity conservation

Water taro gardens play a crucial role in preserving biodiversity by maintaining local taro varieties and supporting agrobiodiversity. This conservation effort is essential for the resilience of crops to climate change impacts, pests, and diseases. By promoting diverse crop cultivation, taro gardens contribute to ecosystem services such as pollination and nutrient cycling, enhancing overall agricultural sustainability (Altieri, 2018).



#### 4.1.4. Impact on agrifood systems

Water taro, or *Colocasia esculenta*, is integral to agrifood systems due to its nutritional value and versatility. Rich in essential nutrients like vitamins A and C, and potassium, water taro supports dietary diversity and health. Its adaptability to various culinary uses makes it a staple in many cultures, providing economic opportunities for farmers, especially in the Pacific region (FAO, 2021).

The FAO-GEF project in Vanuatu emphasizes sustainable land management, with water taro cultivation reducing soil erosion and improving water quality. By preserving traditional knowledge and practices, the project ensures the sustainability of agrifood systems and enhances community resilience (Thaman, 2020).

#### 4.1.5. Equity and social impact

Water taro cultivation promotes equity by empowering small-scale farmers, Indigenous Peoples, women, and youth. Supporting these groups in sustainable practices enhances food security and economic opportunities, addressing social inequalities. The FAO-GEF project exemplifies how inclusive approaches can strengthen community resilience and promote sustainable development (UNDP, 2020).

## 5. CONCLUSION

The innovative integration of water taro gardens within the FAO-GEF project in Vanuatu showcases a sustainable model for climate-resilient agriculture. By leveraging traditional knowledge and sustainable practices, this system enhances food security, biodiversity, and community resilience. The project's success highlights the potential for scaling and replication, offering valuable insights for global efforts in sustainable agriculture and climate adaptation.

The FAO-GEF project Integrated Sustainable Land and Coastal Management in Vanuatu (2019-2024) has been instrumental in promoting and supporting the innovative and climate-resilient indigenous food system that combines water taro, shrimp, eel, and watercress. This unique system has emerged as a promising model for sustainable agriculture, particularly in the context of small island developing states like Vanuatu, which face significant challenges due to climate change, limited land resources, and the need for food security.

The success of this indigenous food system can be attributed to several key factors. First, it leverages the traditional knowledge and practices of the local communities, who have developed and refined this system over generations. By combining multiple species in a symbiotic relationship, the system maximizes the use of available resources and enhances the overall productivity and resilience of the agricultural ecosystem. The integration of water taro, shrimp, eel, and watercress creates a diverse and balanced system that is less vulnerable to the impacts of climate change, such as droughts, floods, and pests.

Moreover, the system employs innovative solutions to address the specific challenges faced by small island developing states. For example, the use of raised beds and irrigation systems helps to optimize water management and prevent soil erosion, while the incorporation of organic matter and mulching techniques improves soil fertility and moisture retention. These practices not only enhance the productivity of the system but also contribute to its long-term sustainability by conserving natural resources and reducing the reliance on external inputs.

The FAO-GEF project has played a crucial role in supporting the development and scaling up of this indigenous food system. Through capacity building, technical assistance, and the provision of necessary resources, the project has empowered local communities to adopt and adapt this system to their specific contexts. The project has also facilitated the sharing of knowledge and experiences among different communities, enabling the dissemination of best practices and fostering a sense of ownership and pride in this unique agricultural heritage.



The outcomes and impacts of this indigenous food system have been significant. It has contributed to improved food security and nutrition for local communities, providing a diverse range of nutrient-rich foods that are readily available and accessible. The system has also generated income opportunities for farmers, particularly women, who play a key role in the management and harvesting of the crops. By diversifying their livelihoods and reducing their vulnerability to external shocks, this system has enhanced the resilience of local communities and their ability to adapt to the impacts of climate change.

Furthermore, the indigenous food system has demonstrated its potential for scaling up and replication in other regions facing similar challenges. The success of this model has attracted the attention of policymakers, researchers, and development practitioners, who recognize its value in promoting sustainable agriculture and building resilient food systems. The FAO-GEF project has been instrumental in documenting and disseminating the lessons learned from this experience, providing a valuable resource for other countries and communities seeking to develop similar systems.

The involvement of various stakeholders, including local communities, government agencies, and international organizations, has been critical to the success of this indigenous food system. By fostering partnerships and collaboration, the FAO-GEF project has ensured that the system is inclusive, equitable, and responsive to the needs and priorities of the local communities. This participatory approach has not only enhanced the effectiveness of the system but also strengthened the sense of ownership and commitment among all stakeholders.

In conclusion, the innovative and climate-resilient indigenous food system in Vanuatu, combining water taro, shrimp, eel, and watercress, presents a promising model for sustainable agriculture. With the support of the FAO-GEF project Integrated Sustainable Land and Coastal Management, this system has achieved significant outcomes and impacts, demonstrating its potential for scaling up to enhance food security and resilience in the face of climate change. By addressing key challenges and employing innovative solutions, this system has showcased the value of traditional knowledge and practices in developing sustainable and resilient food systems. The involvement of various stakeholders and the focus on equity further strengthen the system's potential for positive impact. By sharing knowledge and experiences, this model can inspire and guide the development of similar systems in other regions facing similar challenges, contributing to the global efforts to achieve sustainable development and build a more resilient future for all.

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## Responsibilities and conflicts of interest

The author declare that there is no conflict of interest in relation to the publication of this article.



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