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Assessing the sustainability and resilience of cacao-cased farming systems in Pili, Camarines Sur, the Philippines

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Abstract—Camarines Sur, located in the Bicol Region of the Philippines, is considered one of the most climate-vulnerable provinces. Despite this, it is a model for a robust and proactive disaster risk reduction and management (DRRM) program. The province features a diverse agroecological landscape, ranging from hilly and rolling terrains to plains surrounding Mt. Isarog National Park, which covers an area of 10.112 hectares with an elevation reaching 1.966 meters above sea level. Farming systems include monocropping, intensive multiple cropping, and agroforestry, with sugarcane and corn on downslopes, groundnuts and vegetables on lower slopes, and irrigated or rainfed rice fields. The integration of cacao (*Theobroma cacao L.*) is increasingly being explored as a means to enhance both the sustainability and resilience of these farming systems. This study aims to assess the sustainability and resilience of cacao cultivation at the farm level in Barangay Binanuanan, Pili, Camarines Sur. A qualitative research design was employed, utilizing semi-structured interviews with local government officials, focus group discussions with farmers, and a Strengths, Opportunities, and Challenges (SOC) analysis. Findings indicate that cacao farming contributes to economic sustainability, as most farmers benefit from diversified income sources, including off-farm employment and family financial support. Ecological sustainability is supported by cacao's compatibility with existing farming practices. However, social resilience remains limited, as evidenced by the aging farming population and minimal youth engagement in agriculture. To strengthen overall system resilience, targeted interventions promoting youth participation and community engagement in cacao-based farming are recommended.

Keywords—**cacao, climate-vulnerable, farming system, resilience, sustainability**

INTRODUCTION

The province of Camarines Sur, Bicol Region is one of the most vulnerable to climate change but is a model of having a robust and proactive disaster risk reduction management program. The hilly, rolling to plains landscape surrounding the foothills of Mt. Isarog, a national park with an area of 10.112 ha highest elevation of 1966 masl level diversified farming systems, ranging from monocropping to intensive multiple cropping systems including agroforestry on the midslope, sugarcane, corn on the downslope and groundnuts and vegetables on the lower slopes and irrigated and rainfed rice. According to Waha et al. (2020) multiple cropping is a way of intensifying agricultural production and diversifying the crop mix for economic and environmental benefits.

Maintaining global food security will become increasingly difficult in the coming decades. Not only is population growth making this a daunting task, but it is also important to provide healthier, more nutritious food, distribute food in an affordable and inclusive manner, and maintain the productive capacity of natural resources, increasing the need to mitigate and adapt to climate change (Alho et al., 2021). According to Saputro et al. (2021) Since food is an important part of human survival, governments focus on nutritional development based on the value of food security indicators. One of the efforts to maintain food security in the Bicol region is to cultivate cacao.

Cacao (*Theobroma cacao L.*) is developing as an important economic development engine in several countries throughout the world like the Philippines. As cocoa beans' supply and demand imbalance widens in recent years, the cacao industry has begun to acquire traction in domestic and international markets, resulting in increased recognition for the industry (BPI 2017). It was projected that by 2020, global cocoa demand is anticipated to be between 4.7 and 5 million metric tons (MT), and production capacity would be 1 million MT short. Along with the rising demand for the commodity, cocoa bean output has skyrocketed due to the rapid expansion of small farmer participation. According Departmen of Trade and Industry (2017) the increase in the global market is a chance for the Philippines to expand its economy and create more jobs. Despite

significant competitive advantages, the Philippines' participation in the cocoa-chocolate engagement is limited.

The Department of Agriculture (DA) via the High-Value Commercial Crops (HVCC) program has been aggressively selling cacao manufacturing withinside the Bicol vicinity, such as Camarines Sur. Targeting to intercrop with cacao at the least 10% of the greater than 240000 hectares of coconut areas, DA is positive that with the aid of using presenting nearby farmers with the modern manufacturing era may be a step closer to making the vicinity a first-rate manufacturer of this high-fee crop, giving farmers an intercrop which could supply a further profits of as much as Php 60000 in line with cropping season (Waha et al*.,* 2020).

This expansion of cacao throughout the agroecosystem, from backyard to commercial scale, is a local and national policy, among other things, on sapling delivery, production and post-production technical training, processing facilities, market support, and crop insurance and supported by the program (Templer et al., 2018; Cabell et al., 2012; Sandhu et al*.,* 2010). Things should increase the income of farmers who have traditionally relied on income from a single crop, such as coconut, and increase their opportunities to mitigate poverty. However, while the future of cocoa in the global market is bright, premium chocolate sales, which account for 25% of the market and have annual sales of $ 4.5 billion, continue to grow, while the Philippines in 2013 Produced only 6,000 tons of cocoa. Import of about 30000 tons per year (PSA 2012; Armengot et al.,. 2021).

Bicol's expansion program aims to contribute to the national goal of planting 500 million trees and achieving 100000 tonnes of production by 2020 (PSA 2020). Potential yields will increase, and farmers will not be able to achieve the expected benefits. The low quantity, unreliability, and mixed quality of produce, especially from smallholders, can raise marketing concerns and discourage farmers from taking care of their crops (Connor 2013; Singh et al., 2021) . Incorporation of cocoa is believed to have the potential to improve the resilience and sustainability of Camarines Sur's agricultural production (Lirag 2021; Cocoa Market Review 2017). The aim of this study is to assess the farm level sustainability and resilience of expanding area of cacao as a component of farming systems in Camarines sur.

This study uses a qualitative approach to capture the complex, context-specific realities of sustainability in cacao-based farming systems in Camarines Sur (Nera et al*.,* 2020). It explores farmers' perceptions, local knowledge, policy implementation, and adaptive strategies—key elements that quantitative methods alone cannot fully reveal in assessing resilience and long-term sustainable development.

A qualitative approach is essential to understand sustainability in Camarines Sur's cacao farming (Nera et al*.,* 2020). It captures local knowledge, farmer motivations, policy dynamics, adaptive capacity, and social equity—dimensions often missed by quantitative methods. This approach reveals how diverse actors experience and navigate the transition toward resilient, inclusive, and sustainable agricultural systems.

MATERIALS AND METHODS

Study Location

This study was conducted in Pili, Camarines Sur, the Philippines (Figure 1). Pili, officially the Municipality of Pili, is a 1st class municipality and the capital town of the province of Camarines Sur.

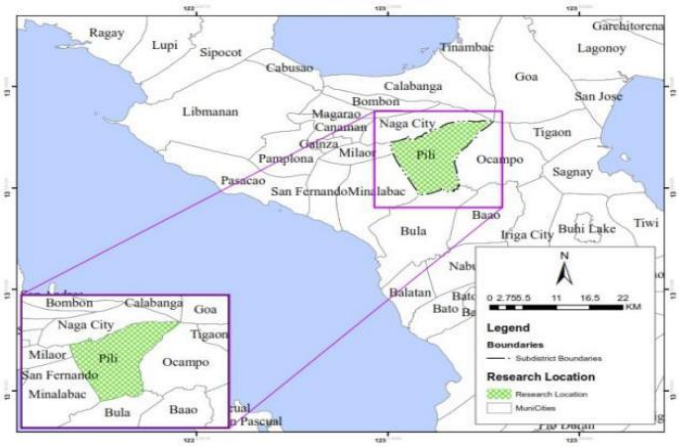

Figure 1. Study location

Binanuaan is a barangay in the municipality of Pili, in the province of Camarines Sur. The main source of livelihood in the barangay is farming. The major agricultural crops in the upland agro-ecological zone are corn, root crops (sweet potato, cassava, and taro), commercial crops (Cacao, coconut, banana, coffee), and fruit trees (Indian mango, pili, caimito and santol).

Data Collection

This study used a qualitative research design to collect comprehensive and context-specific data on cacao-based farming systems in Barangay Binanuanan, Pili, Camarines Sur. Primary data collection methods included semi-structured interviews and focus group discussions (FGDs). Semi-structured interviews were conducted with key local government officials, including representatives from the municipal agriculture office and disaster risk reduction and management (DRRM) unit, to understand institutional support, policy implementation, and integration of cacao into local agricultural planning. Meanwhile, FGDs were conducted with smallholder farmers selected through purposive sampling, particularly those currently practicing or transitioning to cacao farming.

These discussions aimed to capture farmers' lived experiences, motivations, farming strategies, and perceived benefits or constraints of integrating cacao into their current cropping systems. To ensure diverse perspectives, participants were selected based on age, farm size, cropping pattern, and involvement in off-farm income-generating activities. In addition, field observations were conducted to complement the interview data and validate information on land use patterns, agroforestry practices, and infrastructure. All data were audio-recorded, transcribed, and coded for analysis. Ethical considerations such as informed consent, confidentiality, and voluntary participation were strictly adhered to during the data collection process.

Data Analysis

The collected qualitative data were analyzed using thematic analysis combined with a Strengths, Opportunities, and Challenges (SOC) framework (Purnima *et al.* 2022). Transcripts from interviews and focus group discussions were first carefully read and coded, with emergent themes related to economic, ecological, and social dimensions of sustainability identified. Coding was both deductive, guided by the study's objectives, and inductive, allowing new patterns to emerge from the narratives.

The SOC framework (Purnima et al*.,* 2022), facilitated the categorization of findings into three main areas: (1) Strengths, such as cacao's ecological compatibility with existing farming practices and its contribution to diversified income; (2) Opportunities, including increasing market demand, potential value chain development, and land suitability; and (3) Challenges, such as limited youth engagement, aging farmers, and lack of technical support. Data triangulation was employed by comparing insights across different stakeholders (e.g., farmers and officials) and data sources (e.g., interviews and observations), increasing the credibility and reliability of the findings. NVivo software was optionally used to support the organization and visualization of coded data. The analysis aimed to provide a comprehensive understanding of how cacao cultivation contributes to the sustainability and resilience of local farming systems.

RESULTS AND DISCUSSIONS

Agroecological Characteristics and Farming Practices in Pili, Camarines Sur

The municipality of Pili, located in Camarines Sur, Philippines, represents a typical rural agricultural landscape where farming remains the primary source of livelihood. The barangay of Binanuaan, in particular, exhibits characteristics of an upland agroecosystem, with a diverse cropping pattern that includes corn, cassava, sweet potato, banana, coconut, and cacao. Farmers predominantly practice intercropping, such as cacao with banana or fruit trees, which is consistent with agroecological principles promoting biodiversity and land-use efficiency (Nursalam et al*.,* 2021).

Semi-structured interviews with twenty elderly household heads (mean age: 50 years; education: 7–9 years) revealed an average farm size of approximately 3.05 hectares, with 1.25 ha dedicated to home gardening and 2.8 ha for staple crops. Crop calendars suggest year-round cultivation of vegetables and cereals, although input use remains limited and largely unstandardized. The majority of farmers apply 14:14:14 NPK fertilizer and pesticides irregularly, with minimal technical supervision. These practices reflect both the resilience and vulnerability of smallholder systems in the region. While intercropping and crop diversification enhance adaptive capacity, the lack of access to extension services and agronomic training poses significant challenges to sustainable intensification (Luo et al*.,* 2022; Notaro 2014).

These findings are significant as they provide concrete evidence of how traditional intercropping and crop diversification practices in upland agroecosystems, such as those in Binanuaan, embody agroecological principles that support both ecological stability and food security. The key contribution of this study lies in revealing the dual nature of these smallholder systems: while practices like cacao-banana intercropping demonstrate local knowledge and adaptive strategies that promote biodiversity and land-use efficiency, the limited use of standardized inputs and sparse access to extension services underscore persistent institutional and technical gaps. By documenting these dynamics, the study contributes valuable insight into the resilience-vulnerability nexus in rural agricultural communities, highlighting the need for targeted interventions to support sustainable intensification and climate adaptation in similar contexts across the Philippines and beyond.

Status of cacao food system in the area

Based on our observation, rice is the dominant agro food system in Pili, where the most farmers rely on. Beside rice mono-cropping practice the agroforestry is a common farming system, which provides a high variety of crops (e.g coconut, cacao, sugarcane, mango, taro, rice, pineapple, cassava) and non-crops (e.g ornamental flowers and weeds). Cacao is mostly used as an integrated system most combined with coconut, banana or mango, which provides shade, moisture retention and minimize impact of typhoon (Zanmassou 2020). The existing cacao production in the Pili region is still at the beginning, which reflects the amount of existing cacao trees. Most farmers have just few unknown cacao trees in the backyard (Waha et al*.,* 2020).

Additionally, the farmers have planted seedlings provided by the government. Most source of planting materials are distributed by DA (Department of Agriculture) and came mainly from Davao region. The survival rate of the planted seedlings was only 10 %, because the farmers lack on technical knowledge on cacao production after the seedlings were released (Scialabba et al*.,* 2010). The cacao represents a side crop, which adds some income. The existing old cacao trees are a source of scion for farmers who propagated cacao seedlings in their farm. The management of the cacao trees is lacking (Scialabba et al*.,* 2010). By analysing the farm, it is common to observe no farming practices like pruning, weeding or pest management. Some of farmers are also not familiar of picking the matured cacao pods. Most of the cacao trees are infested by the rot disease. Farmers practice inorganic farming (contrary to farmer's responses) by using minimal synthetic fertilizer and pesticide for cacao.

The findings reveal early-stage cacao integration in Pili's rice-based system, showing potential benefits of agroforestry. However, a key issue is the gap between government seedling distribution and farmers' limited technical knowledge. This highlights the need for stronger extension services to support sustainable agroforestry transitions and improve farmer capacity.

Stakeholder around Binanuanan Farmer Cacao Development Association (BFCDA)

The government, through the Department of Agriculture, provides seedlings, pesticides, and fertilizers. The

distribution of cacao seedlings stopped in December 2018 in coordination with LGU (Local government unit). Most farmers were recipients of the Comprehensive Agrarian Reform Program distributed lands to landless farmers through the Department of Agrarian Reform. The LINKSFARM Project under the umbrella of the Department of Agriculture links farmers to mainstream markets (e.g, supermarket) and increases farmers' income by eliminating middlemen in the value chain.

The LINKSFARM has started 2019 and is currently lacking in the moment on cacao supply. Department of Trade and Industry provides training on packaging, labelling of products, and organizing trade fairsand DOST (Department of Science and Technology) for product safety and good manufacturing practices.VLFED (Village Level Focus on Enterprise Development) is supported by the FDA (Bureau of Food and Drugs) and the NFA (National Food Authority), which assists processors to secure an FDA certificate and supports trade fair events. ATI (Agricultural Training Institute) provides training and access to new technology, and provides research grants and scholarships for farmers' children. BPI (Bank of Philippine Islands) conducted a community needs assessment through the SOIL (Social Immersion Laboratory) Project, which assists farmers to write proposals for feasibility studies CBSUA (Central Bicol State University of Agriculture) supports the development of agrotourism and cacao production. They also commit to helping PPC with writing project proposals.

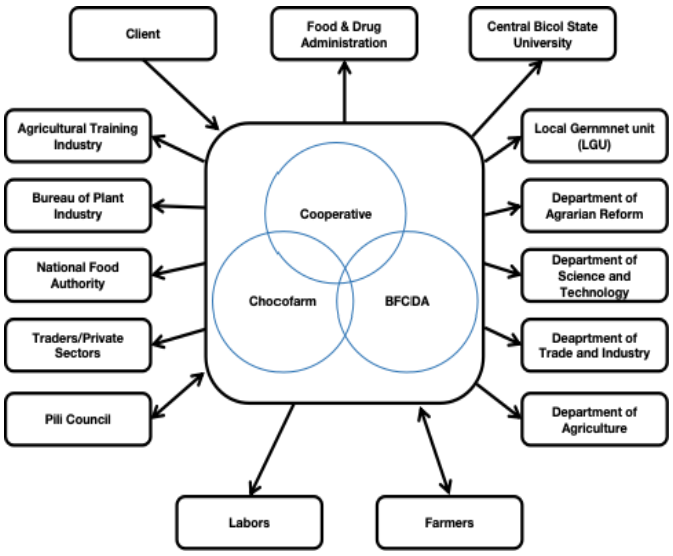

Figure 2. Net Map of Stakeholders around BFCDA

As mentioned by the BFCDA, the Choco Farm and the association are important key players in the Pili area to promote and process cacao. If we take a closer look at the association, it started in 2009 when different farmers met and established the association. After attending different trainings and assessments from the DA and DTR the association was able to produce the first tableya and bars in 2013 and convinced the government of the high quality of output to support the association. In 2014, the Program "High Value Crops Development Program" (HVCD) of the Department of Agriculture started to expand the cacao production in the Philippines. The association received 500 seedlings, which were distributed among the members. They joined the trade fair in the year 2015. In 2017, the BFCDA started the construction of their cacao processing facilities and received 140.000 seedlings. In 2018, they started production with the newly established facilities financed by the government with the support of DTI, DOST, and DAR. In 2019, they are waiting for the approval of the FDA Permit. With this new certificate, farmers will be encouraged to intensify and improve the productivity of cacao production. This will open new opportunities to market their product to the domestic and international markets.

Sustainability and resiliency of cacao food system in Pili, Camarines Sur

Department of Agriculture and other government agencies such as the Department of Trade and Industry, the Department of Sciences and Technology, and the Department of Agrarian Reform. As a way to encourage young generations to engage in agriculture, the regional office of the DA Department of Agriculture conducted a school garden project and awarded "best garden" in primary and secondary public schools.

Table 1 showed that the strengths identified highlight the area's natural buffer capacity, such as biodiversity and the integration of cacao into multi-storey agro-ecosystems. Farmers benefit from low input requirements for cacao cultivation, including minimal pesticide and fertilizer use and reduced water needs. Furthermore, self-regulation practices such as the use of compost, natural windbreaks, and access to irrigation demonstrate adaptive capacities already in place. Opportunities were identified across multiple dimensions. Institutional support for farmer training and knowledge dissemination through local associations represents a significant potential for scaling best practices. The presence of uncharacterized cacao varieties opens up possibilities for genetic conservation and localized seed propagation. Additionally, government programs and interest group networks can be leveraged to enhance climate resilience and resource management. Despite these strengths and opportunities, several challenges remain. There is a noticeable gap in technical knowledge application, with many farmers lacking the skills for proper pruning, pest management, and soil analysis. The decreasing participation in farmer organizations also poses a barrier to collective learning and action. Moreover, the sustainability of government-led initiatives is uncertain, and awareness of climate change and environmental policies remains limited. The SOC framework enabled the identification of key leverage points for improving sustainability and resilience in the local cacao farming system. These findings underscore the need for targeted capacity-building, improved farmer engagement, and consistent institutional support to achieve long-term development goals.

Table 1. Strengths, Opportunities, and Challenges (SOC) analysis (Purnima *et al.* 2022)

Category	Strengths	Opportunities	Challenges
Buffer Capacity			
Biodiversity	High diversity of crops and animals/fisheries; 500 cacao trees recorded	Source of cacao genetic diversity; potential for propagation	Many cacao trees are uncharacterized; planting materials from Davao have low survival rate
Farm Management	Minimal synthetic pesticide/fertilizer use by some farmers	Institutional support for training and knowledge-sharing	Poor farm practices: lack of pruning, harvesting, weeding, and pest control
Resource Management	Agroforestry integration with shade-providing trees; low fertilizer and water needs	Studies and interest groups can assist in soil sampling and knowledge dissemination; government-supported irrigation	Lack of planting plan; insufficient soil analysis; acidic soil; irrigation allocation during drought
Self-Regulation			
Ecological	Minimal pesticide use; use of compost/manure	–	No soil analysis; no monitoring of irrigation
Disaster Risk Management	Use of trees as windbreakers; access to irrigation during drought	Government programs to reduce vulnerability	Sustainability of government programs
Interest Groups	Farmers are linked with associations (e.g., BFCDA, PPC)	More networks for access to market, information, and technology	Declining participation in associations
Learning and Adaptation			
Vulnerability Assessment	Early warnings received; crop schedule adjusted according to weather	Increased awareness and preparedness	Limited climate change awareness; lack of public information dissemination
Knowledge Sharing	Farmers share pest control methods; demo farms available	–	Trainings lack focus on technical aspects like planting, pruning, and climate change mitigation
Knowledge Application	Planting schedules adjusted	–	Poor application of farm management knowledge
Policy Environment	–	–	Lack of enforcement and awareness of ordinances (e.g., against crop residue burning)

Source: Primary Data (2019)

The main challenge of the sustainability of cacao production in the local area is the reliance of the major source of planting materials from Davao and low survival rate of the seedlings. Amidst the different development programs, sustainability of the project is still an issue. Also, farmers easily shift the type of crops to cultivate. The MAO (Municipal Agriculture Office) provides free cacao seedlings to farmers which are sexually propagated. However, the varieties of planting materials are not properly identified. They also cited that the timing of distribution of seedlings is incorrect given that some are released nearly during dry season. As of January 2019 to present, no free seedlings were given. In processing and marketing, the difficulty to secure the FDA license limits processors to reach the mainstream market and most of them disregard the appropriate standard of processing cacao. There is a high demand of cacao to the market, but few farmers are still involved to the process.

Another challenge is also to find new markets and to improve the quality to process the cacao pods in chocolate. Actually 600 farmers are registered to the LINKSFARM

project but only 260 are really helped. Concerning the cacao, the cluster system needs to be improved. Indeed, a lot of cacao trees have been planted 8 months to 1 years ago. Thus, most of them are not yet productive. The main challenge of the LINKSFARM project implementation are quality standardization and higher volume of cacao. To address the challenges, clustered farmers sell the pods and ferment together for the uniformity of the quality. Also, grafted cacao seedlings were encouraged to meet the volume needed by the market. Even when insurance is free, farmers are not able to register their crops. Farmers are reluctant to attend meetings and orientations because previously affected farmers did not receive any compensation from the insurance company.

These findings are critical in revealing the systemic challenges that undermine the sustainability of cacao production in Pili, despite multi-agency support and high market demand. The key contribution of this study lies in uncovering the misalignment between government interventions—such as poorly timed seedling distribution, lack of varietal identification, and insufficient post-distribution support—and the actual needs and behaviors of farmers. Additionally, persistent issues in market access, quality standardization, and weak farmer participation in institutional programs (e.g., LINKSFARM, crop insurance) point to structural limitations in implementation. This study provides valuable insights into the socio-technical gaps that must be addressed to realize sustainable and inclusive cacao value chain development in rural agroecosystems.

CONCLUSIONS

This study evaluated the resilience and sustainability of the cacao production system in Binanuaan, Pili, Camarines Sur, focusing on ecological, economic, and social dimensions. Ecological indicators suggest that the system is resilient in terms of buffer capacity and self-organization. Crop and livelihood diversification, including livestock and fisheries, enhances the farmers' ability to absorb environmental and economic shocks. The minimal use of synthetic inputs and the gradual transition to organic practices indicate a positive trend toward sustainable farming. However, proper farm management practices such as pruning, weeding, integrated pest management (IPM), and harvesting based on fruit maturity are not consistently applied. Most farmers are linked to local organizations that facilitate access to technical support, especially in pest control and input availability. However, training programs offered by the national government tend to focus on cacao processing rather than on-farm production practices. Economically, the system shows resilience through diverse income sources and external financial support. Social resilience, however, is less evident due to an aging farmer population and minimal youth engagement in agriculture. To strengthen the long-term sustainability of the cacao food system, it is essential to increase youth participation in cacao production and development initiatives, thereby addressing the vulnerabilities in the social dimension and ensuring intergenerational continuity.

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