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Balancing Tradition and Innovation: The Role of Environmental Conservation Agriculture in the Sustainability of the Ifugao Rice Terraces

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Abstract: This study investigates the continuation of Environmental Conservation Agriculture (ECA) practices among farmers in the Ifugao Rice Terraces, a Globally Important Agricultural Heritage System (GIAHS) in the Philippines. Through a cross-sectional survey of ECA farmers in the municipality of Banaue, this research explores the socio-demographic, environmental, and economic factors influencing the adoption and persistence of ECA. The findings reveal that while access to resources such as high-yielding seeds, modern farming equipment, and financial support is important for the adoption of ECA, the shift toward high-yielding varieties has contributed to a decline in the cultivation of Tinawon rice, which is vital for maintaining the ecological balance and cultural heritage of the terraces. This study underscores the importance of balancing modern agricultural practices with the continued cultivation of Tinawon rice to preserve biodiversity, soil health, and cultural identity, while also enhancing agricultural productivity. Additionally, the roles of community-based support systems, market access, and financial incentives are highlighted as key factors in sustaining ECA practices. Climate change presents both challenges and opportunities for adaptation, making it essential to integrate traditional knowledge with modern techniques to build resilience. Understanding the factors that shape ECA continuation is crucial for refining initiatives that address both the economic and cultural contexts. By emphasizing the importance of tailored, community-driven interventions, this study provides critical insights for enhancing ECA adoption in the Ifugao Rice Terraces, contributing to climate resilience and the long-term sustainability of this significant agricultural heritage system.

Keywords: environmental conservation agriculture; Globally Important Agricultural Heritage System; Ifugao farmers; Ifugao rice terraces; climate change mitigation; sustainable agriculture

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1. Introduction

Agriculture plays a crucial role in shaping the cultural, economic, and ecological landscapes of communities around the world. A prime example of this is the Ifugao Rice Terraces in the Philippines, which are recognized as part of the Globally Important Agricultural Heritage Systems (GIAHSs). This designation, granted by the Food and Agriculture Organization (FAO) of the United Nations, highlights the terraces' exceptional value for both sustainable agriculture and cultural preservation [1]. These terraces, with their complex systems of irrigation and soil management, have sustained local farming communities for centuries. The Ifugao Rice Terraces are a model for sustainable farming, blending traditional agricultural practices with modern conservation techniques. These techniques include the use of natural fertilizers, contour farming, and biodiversity preservation, which contribute to the terraces' ecological health. These methods help mitigate soil erosion, maintain water systems, and enhance resilience to climate change, ensuring the long-term sustainability of the terraces and their surrounding environment. However, the Ifugao Rice Terraces face increasing pressures from modern agricultural practices, climate change, and socio-economic challenges [2]. This study focuses on ECA farmers within the GIAHS area of Ifugao, specifically in the municipality of Banaue, to explore the continuation of Environmental Conservation Agriculture (ECA) practices. ECA is seen as an effective means of fostering sustainability and resilience in the face of climate change while preserving traditional agricultural knowledge and practices.

This research aims to explore the socio-demographic, environmental, and economic factors that are associated with the adoption and continuation of ECA among these farmers. It also seeks to investigate the interplay between climate change, agricultural practices, and the long-term sustainability of the Ifugao Rice Terraces. The findings of this study have implications for improving agricultural policies and support systems to sustain traditional farming systems in the face of modern challenges, ensuring that these heritage sites continue to thrive for generations to come.

1.1. Environmental Conservation Agriculture in the Ifugao Rice Terraces

The Ifugao Rice Terraces stand as a remarkable testament to indigenous agricultural practices that prioritize environmental sustainability. Recognized as a UNESCO World Heritage site in 1995, the terraces are renowned for their intricate irrigation systems and their role in fostering local biodiversity. However, these agricultural systems are increasingly threatened by the impacts of climate change, deforestation, and the encroachment of commercial farming practices [2–4]. As a result, preserving these agricultural heritage systems has become a pressing priority, not only for cultural conservation but also for promoting sustainable farming practices that can serve as models for other regions facing similar challenges.

The concept of a GIAHS, introduced by the Food and Agriculture Organization (FAO) in 2002, underscores the significance of traditional agricultural systems in maintaining biodiversity and advancing environmental sustainability [5]. The GIAHS designation highlights agricultural landscapes that have evolved over time, where indigenous farming methods have developed in harmony with the natural environment [1]. In 2011, the Ifugao Rice Terraces were recognized as a GIAHS site, embodying the ideal of blending culture, agriculture, and environmental stewardship.

ECA is an innovative farming approach that merges traditional and modern practices to enhance sustainability, resilience, and climate adaptation [6]. ECA emphasizes reducing chemical inputs, conserving water, improving soil health, and preserving local biodiversity [7]. Studies in Japan have demonstrated how ECA contributes to mitigating climate change by reducing greenhouse gas emissions, showcasing its potential as a sustainable farming practice [8,9]. In the context of the Ifugao Rice Terraces, traditional farming practices already align closely with the principles of ECA, offering a strategy to maintain the delicate ecosystems of the terraces while ensuring food security for local farmers.

For generations, Ifugao farmers have employed sustainable methods that naturally fall under the umbrella of ECA [6,10]. They use organic fertilizers and pesticides, practice composting, and implement crop rotation to maintain soil health and fertility. Additionally, indigenous pest management techniques, such as utilizing natural predators or plant-based solutions, help control pests without resorting to harmful chemicals [11]. These time-tested practices not only protect the environment but also contribute to the resilience of the rice terraces against environmental pressures.

While ECA supports the adoption of high-yielding and drought-resistant crop varieties, it ensures that these crops are cultivated using organic inputs or sustainable practices. This approach ensures that increased productivity does not come at the expense of the terraces' environmental health. By combining modern crop varieties with traditional, environmentally friendly practices, ECA allows farmers to enhance productivity without compromising the ecological integrity of the rice terraces. This integration of traditional knowledge and modern sustainable techniques exemplifies the core values of ECA, ensuring farming practices remain environmentally resilient, economically viable, and culturally sustainable.

However, the introduction of high-yielding varieties, while offering higher yields and greater resilience, has led to a decline in the cultivation of Ifugao's heirloom rice, particularly the Tinawon variety [12]. Cultivated in the terraces for several decades, Tinawon rice is a key element of both the ecological and cultural identity of the terraces. This traditional variety is well-adapted to the terraces' unique microclimates and irrigation systems, offering resilience to local environmental conditions and contributing to the region's biodiversity. Tinawon rice is also prized for its distinct flavor and nutritional value. The highest recorded harvest of Tinawon rice was in 2015, with 26,070.25 metric tons (MT) across 8338.25 hectares. However, production declined sharply in the following years, falling to just 4239.9 MT over 1493.60 hectares in 2020, representing a decrease of approximately 83.7% in production over five years. According to Rovillos et al. (2024), several other factors contributed to this decline. The long growing period required for Tinawon is a major challenge, especially in comparison to high-yielding varieties, which can be planted two to three times a year and offer faster returns [12]. Additionally, the labor-intensive nature of Tinawon production demands the involvement of the community throughout the entire process of production. This has become increasingly difficult due to socio-economic factors such as outmigration, where individuals seek better employment opportunities and higher education outside of rice farming [13]. These combined challenges have made it harder for local communities to sustain Tinawon production, leading to a shift toward more economically viable alternatives.

The loss of Tinawon rice and the resulting ecological imbalances underscore the complex challenges facing the Ifugao Rice Terraces [14]. While high-yielding varieties offer short-term economic gains, their widespread adoption has led to biodiversity loss, soil degradation, and the rise of new pests, further intensifying the challenges faced by farmers. These issues highlight the need for a more balanced approach that enhances productivity while preserving the ecological integrity of the terraces and maintaining the cultural heritage tied to traditional crops like Tinawon.

ECA offers a potential solution by promoting sustainable farming practices such as organic inputs, crop rotation, and integrated pest management [8]. Through ECA, Tinawon can be prioritized in designated areas to preserve its cultural and ecological significance, while high-yielding varieties can be cultivated in less prioritized areas using reduced chemical inputs or organic alternatives. This approach helps prevent soil erosion and mitigates the decline of Tinawon planting, ensuring its continuous cultivation. By finding a middle ground, this strategy supports the preservation of Tinawon, the heirloom rice variety of Ifugao, while allowing farmers to earn additional income from high-yielding varieties. This integrated framework fosters a balance between traditional farming practices and modern agricultural needs, ensuring the sustainability of the rice terraces.

Climate change represents a significant threat to traditional agricultural systems worldwide, including in the Philippines [3]. Ifugao Province, in particular, has experienced shifts in weather patterns, such as rising temperatures, more frequent typhoons, and altered rainfall patterns [12]. These climatic changes exacerbate existing farming challenges, including water scarcity, soil erosion, and crop damage. In response, many farmers have adapted by altering planting schedules, diversifying crops, and adopting improved water management techniques. Studies show that these adaptive strategies are crucial for maintaining agricultural productivity and ensuring the livelihoods of farming communities in the face of climate change [14,15].

A growing body of literature suggests that the continuation of sustainable agricultural practices, such as ECA, is strongly influenced by socio-economic factors, including farmers' access to resources, education, and financial support [6,16]. For example, access to high-yielding seeds, modern farming equipment, and irrigation systems is often a barrier to the adoption of conservation agriculture in rural communities. Socio-demographic factors, such as age, education, and community networks, also play critical roles in shaping farmers' decisions to adopt and sustain sustainable farming practices [17]. Additionally, cultural values, including the importance of traditional knowledge and practices, influence the willingness of farmers to integrate modern techniques, with some expressing concerns about the compatibility of new practices with indigenous rituals and beliefs [18].

Despite these challenges, the potential benefits of ECA are evident. Research shows that sustainable practices not only help mitigate climate change but also improve soil health, enhance water retention, and increase biodiversity [19,20]. Furthermore, ECA has socio-economic benefits, such as improved crop yields, enhanced food security, and the empowerment of marginalized groups, including women and youth in farming communities [21]. By exploring the factors that influence the adoption and continuation of ECA among Ifugao farmers, this research aims to contribute to the broader discussion of the role of traditional agricultural systems in fostering sustainability and resilience in the face of modern challenges.

1.2. Theoretical Foundation

The theoretical foundation of this study is grounded in several key frameworks that address the intersections between traditional agricultural practices, sustainability, and climate change adaptation. These include the Sustainable Livelihoods Framework (SLF), Ecological Modernization Theory (EMT), and Resilience Theory. Together, these theories provide a comprehensive lens through which to examine the continuation of Environmental Conservation Agriculture (ECA) practices in the Ifugao Rice Terraces, focusing on how socio-economic, cultural, and environmental factors influence farmers' decisions and practices.

(A) Sustainable Livelihoods Framework (SLF)

The Sustainable Livelihoods Framework (SLF), developed by the Department for International Development (DFID), posits that individuals and households pursue sustainable livelihoods by drawing upon various types of capital—natural, human, social, physical, and financial—within a context of vulnerability, policies, and institutional structures [22,23]. In the case of the Ifugao Rice Terraces, the SLF helps explain how farmers leverage traditional knowledge (human capital), community networks (social capital), and natural resources (natural capital) to maintain sustainable farming practices amidst challenges such as climate change and economic constraints. This framework is particularly relevant to understand how farmers balance their immediate needs, such as food security and income generation, with longer-term sustainability goals.

In the context of the Ifugao farmers, the SLF highlights the critical role of social capital, where strong community networks facilitate the exchange of agricultural knowledge and resources. These networks enable farmers to access support for ECA practices, adapt to climate-induced stressors, and maintain traditional practices that align with sustainability objectives. Furthermore, the SLF suggests that the availability of financial resources (financial capital), such as subsidies or access to microcredit, plays a significant role in supporting sustainable farming practices and overcoming economic barriers.

(B) Ecological Modernization Theory (EMT)

Ecological Modernization Theory (EMT) argues that modern societies can achieve environmental sustainability through technological innovation, institutional reform, and the integration of environmental goals with economic and social development [24,25]. In this study, EMT provides a lens for understanding the integration of modern environmental conservation practices with traditional agricultural systems in the Ifugao Rice Terraces. The concept of "ecological modernization" suggests that the adoption of sustainable farming practices, such as ECA, can enhance environmental outcomes without compromising economic development. The theory posits that technological advances, such as improved irrigation systems and drought-resistant crops, can complement traditional agricultural techniques to increase productivity and environmental resilience.

In the Ifugao context, EMT allows us to explore how farmers incorporate modern sustainable agricultural practices (e.g., organic farming and water management techniques) alongside indigenous practices, like composting and crop rotation. The interplay between these approaches demonstrates the potential for ecological modernization in preserving heritage farming systems while promoting climate adaptation and sustainability. Furthermore, the theory's emphasis on institutional support underscores the role of government policies, subsidies, and community-driven initiatives in fostering the widespread adoption of ECA.

(C) Resilience Theory

Resilience Theory focuses on the capacity of systems—whether ecological, social, or economic—to absorb disturbances, adapt to change, and transform to ensure long-term sustainability [26,27]. Resilience, in this context, is the ability of farmers in the Ifugao region to maintain and adapt their agricultural practices in response to challenges such as climate change, economic hardship, and the erosion of traditional knowledge. The theory is particularly pertinent to understanding how farmers develop adaptive strategies, such as altering planting schedules or diversifying crops, to cope with shifting weather patterns, reduced water availability, and other climate-related disruptions.

By applying Resilience Theory, this paper explores how the ECA practices adopted by farmers serve as mechanisms for building resilience in agricultural systems. These practices—such as organic farming, soil conservation, and integrated pest management—are seen as strategies that enable farmers to maintain the integrity of their farming systems in the face of external stressors. The theory also provides a basis for understanding the dynamic relationship between the social and ecological systems in the Ifugao Rice Terraces, where the resilience of one system supports the resilience of the other, fostering a sustainable and adaptive farming community.

Together, these theoretical frameworks offer a multidimensional perspective on the continuation of ECA practices in the Ifugao Rice Terraces. They highlight the complex interactions between economic, social, cultural, and environmental factors that influence farmers' decisions, providing a foundation for analyzing the factors that drive the adoption and sustainability of ECA practices in this culturally and ecologically significant region.

2. Study Area and Methods

This research centers on ECA practices among farmers within the GIAHS, specifically focusing on the province of Ifugao. Since 2011, Ifugao has held the distinction of being the only site in the Philippines recognized as part of the Globally Important Agricultural Heritage Systems (GIAHSs). This province is renowned for the Ifugao Rice Terraces, a remarkable example of human ingenuity and sustainable agriculture that has gained global recognition. Inscribed as a UNESCO World Heritage Site in 1995, these terraces are celebrated not only for their aesthetic and cultural value but also for their advanced engineering and environmental harmony. Declared national treasures in the 1970s through Presidential Decrees 260 and 1505, the terraces faced significant challenges in the early 2000s, including neglect and a lack of maintenance, which led to their inclusion on the World Heritage in Danger list in 2001. Thanks to concerted efforts by national and local governments, as well as the active participation of the Ifugao community, extensive restoration projects were undertaken. These initiatives addressed structural damages, revived traditional farming practices, and promoted sustainable tourism, culminating in the terraces' removal from the Danger list in 2012. Today, the Ifugao Rice Terraces not only symbolize resilience but also serve as a model for the preservation of cultural landscapes and sustainable agricultural systems in the face of modern challenges.

This study examines two of the five rice terrace clusters in the province: the Batad and Bangaan terraces, located in the municipality of Banaue (Figure 1). Banaue, categorized as a 4th class municipality with an annual income between PHP 40 million and PHP 60 million, is home to 20,652 people across 18 barangays, including Batad and Bangaan, which are both recognized GIAHS clusters. The municipality's classification reflects its economic status and development level.

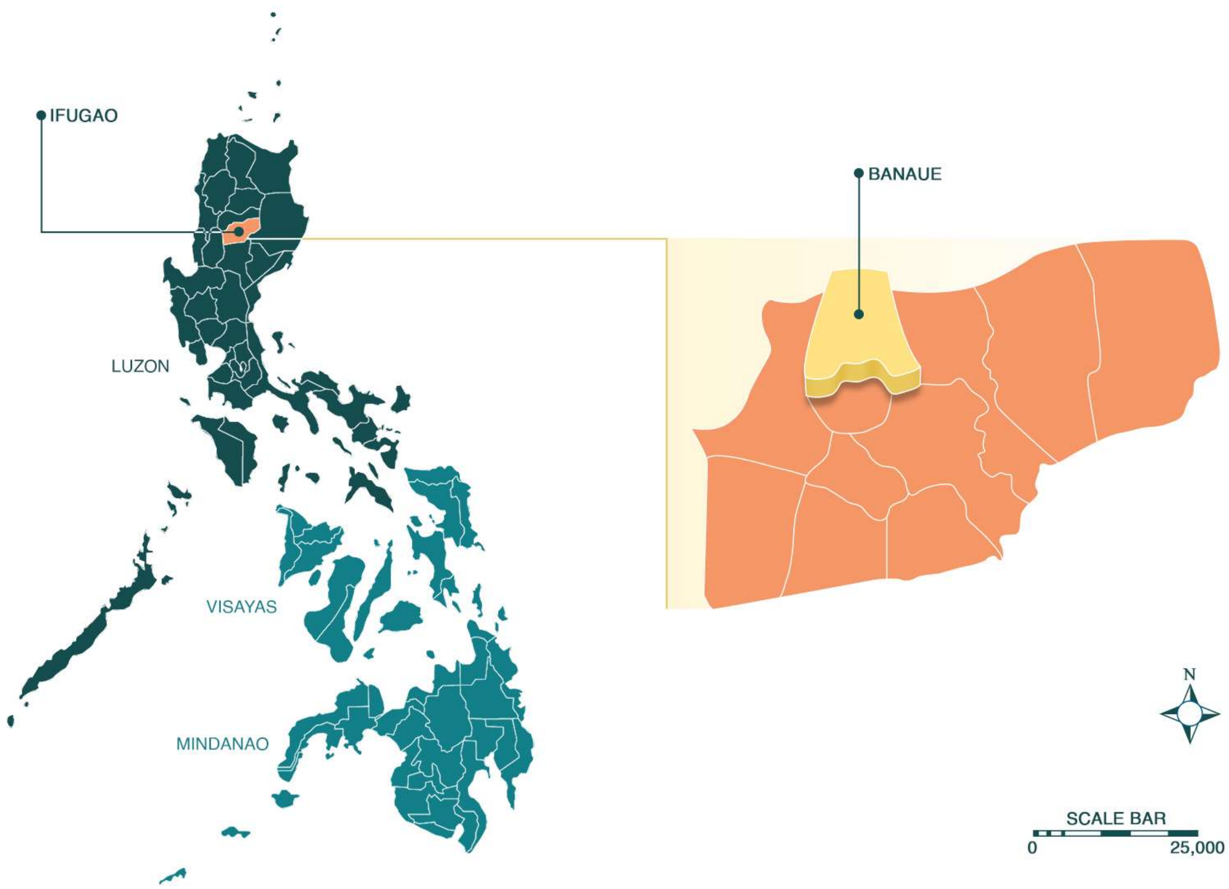

Figure 1. Sampling site of this study.

This research was conducted by the GIAHS Center of Ifugao State University (IFSU), which is dedicated to preserving the terraces through focused research, community engagement, and cultural restoration. The Center also works on agricultural revitalization, biodiversity documentation, and the development of national databases for the indigenous systems associated with the rice terraces. This study was undertaken in collaboration with the Environmental Conservation Agriculture (ECA) project led by Dr. Keshav Lall Maharjan at Hiroshima University.

Preliminary consultations with key stakeholders, such as the mayor of Banaue and local agricultural officers, were conducted to secure approval for this study. A comprehensive list of GIAHS farmers in Banaue was compiled, and from this list, a random sample of 252 farmers was selected for participation. The primary selection criterion was that participants must be farmers within the Batad and Bangaan rice terrace clusters of Banaue, which are officially designated as GIAHSs by the FAO. Data collection took place between December 2022 and January 2023, utilizing a standardized questionnaire administered through face-to-face interviews. These interviews were conducted by field researchers from the IFSU GIAHS Center who were fluent in the local Ifugao language and translated the responses into English for analysis. This study also included additional data collection methods such as focus group discussions, key informant interviews, and on-site observations, which helped enrich the data and provide a deeper understanding of the farmers' practices.

This study adhered to ethical standards outlined in the Declaration of Helsinki, receiving approval from the Ethics Committee of the Graduate School for International Development and Cooperation at Hiroshima University (Approval code: HUIDEC-2022-0090). Researchers followed strict ethical guidelines to ensure the integrity and ethical conduct of this study, and all participants provided informed consent.

The questionnaire gathered socio-demographic and farming-related information, as well as data on ECA practices among farmers in the rice terrace communities of Banaue. The continuation of ECA practices was evaluated using a five-point scale (1-strongly no, 2-no, 3-unsure, 4-yes, 5-strongly yes), which served as the dependent variable in regression analyses. Ordinal logistic regression was used to identify significant factors influencing ECA practices among farmers, with the model fit, goodness-of-fit, and parallel lines tested in SPSS v.27 (IBM, New York, NY, USA). Correlation analyses, including Phi and Cramer's V, Chi-square, and Spearman's correlation analyses, were also performed to deepen the understanding of the data.

This comprehensive research will contribute valuable insights into the sustainability of the Ifugao Rice Terraces and serve as a resource for enhancing environmental conservation agriculture efforts in the region.

3. Results

3.1. Socio-Demographic and Farm-Related Data of ECA Farmers in the Rice Terrace Clusters of Banaue

The study sample of 252 ECA farmers highlights several noteworthy characteristics (Supplementary Table S1). A higher proportion of female respondents (56.7%) compared to males is notable, as farmer-focused studies are often male-dominated. The farmers are predominantly middle-aged, with the largest age groups being 40–49 years old (22.2%), 30–39 years old (20.6%), and 50–59 years old (18.3%), collectively comprising 61.1% of the productive age range of 30–59 years. They also exhibit extensive farming experience, with 67.4% having over 20 years of practice, including 21.0% with 20–29 years and 19.0% with 30–39 years of experience. Newer farmers, with less than 10 years of experience, account for a smaller portion at 14.3%, suggesting a predominantly seasoned farming population capable of intergenerational knowledge transfer. In terms of education, 50.4% of respondents completed elementary school, and 32.5% attained a high school education. Most farmers (65.9%) are married, and more than half (51.6%) live in small households with 2–4 family members, followed by 26.2% with medium-sized families of 5–6 members. Nearly half (43.3%) are affiliated with agricultural organizations, and 89.3% have identified farm inheritors, ensuring the continuity of farming traditions.

In terms of challenges faced in farming, the top issues include low crop yields (98.8%), drought and water scarcity (88.9%), limited irrigation facilities (86.9%), insufficient farming equipment or work animals like carabaos (swamp buffaloes: *Bubalus bubalis carabanesis*) (77.4%), lack of access to high-yielding crop varieties (74.2%), a shortage of labor (73.8%), and insufficient income (67.9%). Despite these challenges, nearly all farmers (99.2%) expressed their intent to continue farming over the next 5 to 10 years.

Economically, farming remains a subsistence-level activity for most respondents, with 77.4% earning PHP 20,000 or below annually and only 4.8% earning above PHP 40,000. Farming expenses are similarly modest, with 65.1% spending PHP 10,000 or below and only 9.9% incurring costs above PHP 25,000. The majority (97.2%) farm primarily for self-consumption, with 94% relying on personal savings as their main source of capital. Farmers also generate supplementary income through remittances from relatives working abroad or outside Ifugao (25.0%), tourism-related activities (24.2%), selling handicrafts or artisan goods (3.6%), and woodcarving and craftsmanship (2.4%).

Farmers widely practice environmentally friendly techniques aligned with ECA principles (Figure 2), such as composting (91.3%), indigenous pest management (85.3%), crop rotation (76.6%), and the application of organic fertilizers (76.2%). Notably, 65.5% avoid chemical pesticides and fertilizers, demonstrating a strong commitment to sustainable agriculture. These practices align with the broader goals of conserving resources while maintaining productivity, highlighting the farmers' role in promoting ecological balance in their communities.

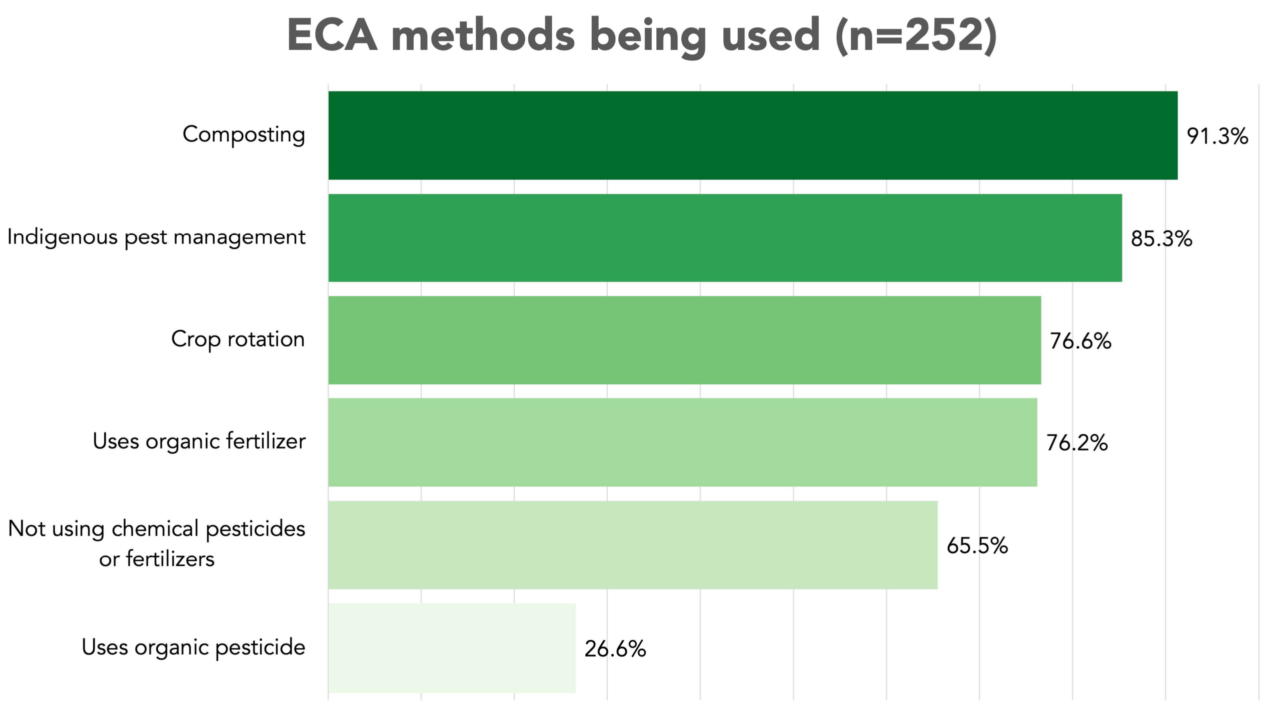

Figure 2. ECA methods being used by the Ifugao GIAHS farmers in this study.

The community values traditional practices, as more than half (56.7%) still incorporate rituals in farming, although only 46.9% believe these rituals remain helpful. These customs are closely tied to the planting of Tinawon rice, an heirloom variety grown in the Ifugao Rice Terraces. Among the rituals that some farmers maintain are tungaw, ngirin, and urpi. Tungoh/tungaw is observed after the mumbaki performs the lukya, marking the first time rice bundles are taken out of the granary or alang for family consumption. Tungoh/tungaw is a day of idleness where people stay home and visitors are not allowed to enter the village. This practice fosters communal rest and reflection. After tungoh/tungaw, other families in the village may perform their own lukya, signifying the interconnectedness of the community's cultural traditions. Ngilin/ngirin starts on the eve of the harvest and is resumed early in the morning of the harvest day. This ceremony is performed before harvesters arrive to reap, aiming to implore the gods and ancestral spirits to grant blessings on the harvest. It also seeks to appease 'jealous' gods, ensuring that the rice harvest proceeds without interference. This rite underscores the community's belief in the spiritual guardianship of their agricultural activities. Kulpi/urpi is performed when new leaves begin to sprout on transplanted rice plants, marking the start of the weeding season. This ritual asks the gods to protect the growing plants, demonstrating the community's proactive care and spiritual connection to their crops. These rituals emphasize the deep cultural and spiritual ties the Ifugao people have with their land and farming traditions. By weaving these ceremonies into the cultivation of Tinawon rice, the community preserves its ancestral heritage while sustaining the rice terraces—a UNESCO World Heritage Site—and passing on valuable indigenous knowledge to future generations. Notably, 84.5% receive farming subsidies, with 76.2% finding them beneficial.

When considering their priorities in farming, farmers emphasized achieving peace of mind (84.9%), minimizing expenses (79.4%), fostering camaraderie (79%), ensuring a high crop quality (78.2%), and maximizing income and yields (78.2%). Their key sources of farming information include co-farmers (94.8%), barangay officials (24.2%), and agricultural technicians (23.4%), while their motivations to adopt ECA practices are influenced by co-farmers (63.9%), family or ancestors (40.1%), and media sources (32.9%).

Farmers identified several key needs to support their agricultural activities (Figure 3). The top priorities include improved irrigation facilities (97.6%), solutions for managing soil erosion in the rice terraces (94.0%), access to modern machinery or carabaos (84.1%), diversified income opportunities (84.9%), high-yielding seed varieties (82.5%), and fair and competitive pricing for harvested crops (66.3%).

Overall, this study portrays a resourceful and experienced farming community navigating economic constraints while balancing traditional and sustainable practices. Their widespread adoption of environmentally friendly techniques underscores a commitment to ecological resilience and productivity. By prioritizing cultural values, collaborative networks, and sustainable agricultural methods, these farmers exemplify a harmonious integration of heritage and innovation, ensuring continuity and adaptability amidst economic and environmental challenges.

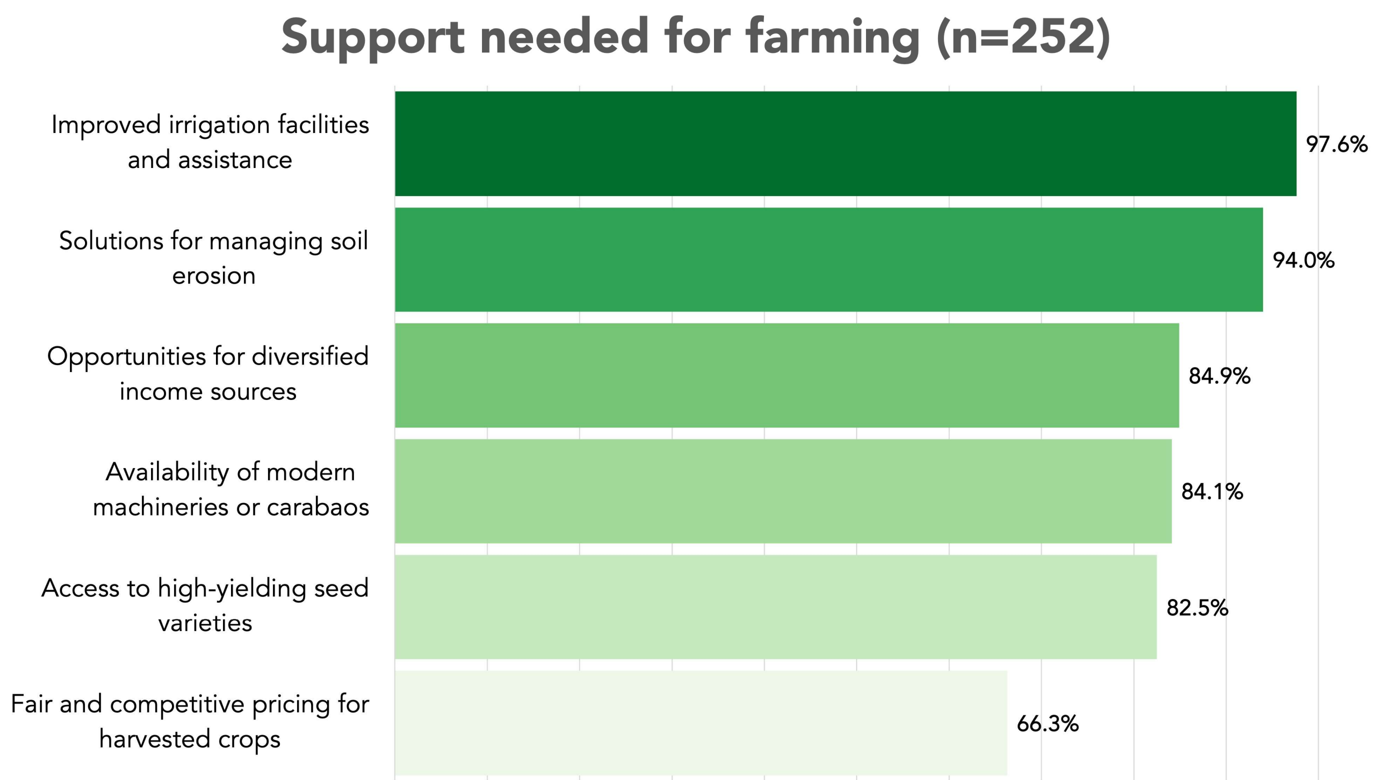

Figure 3. Key needs identified by the Ifugao GIAHS farmers to support their agricultural activities.

3.2. ECA-Related and Climate Change-Related Data of ECA Farmers in the Rice Terrace Clusters of Banaue

A majority of the farmers (82.2%) believe that climate change impacts farming in Ifugao (Supplementary Table S2). The most commonly perceived effects include landslides and erosion (98.0%), crop damage or loss (92.5%), and the loss of arable farmland (88.5%). Other notable impacts are an increased typhoon intensity or frequency (83.7%), changes in the crop distribution (77.8%), rising temperatures or extreme heat (76.6%), and shifts in seasonal patterns (75.4%). To cope with these challenges, farmers employ adaptive strategies such as adjusting planting schedules or staggering crop planting (89.7%), planting high-yield or drought-resistant crop varieties (84.9%), and implementing water management techniques (84.9%). Other strategies include strengthening pest management practices (47.6%), diversifying crops or planting alternative crops (46.4%), practicing sustainable land management (37.3%), and modifying or repurposing farmland (12.7%).

The majority of farmers (88.1%) also believe that their Environmental Conservation Agriculture (ECA) practices mitigate climate change. Interest in ECA remains high, with 48.0% expressing strong interest and 50.0% showing extreme interest. However, only 68.2% indicated that they are likely to continue practicing ECA, while 27.4% are unsure, and 4.4% are unlikely to continue. The key reasons for continuing ECA include promoting personal health and well-being (95.6%), contributing to the local and global environment (94.0%), reducing the use of chemical pesticides and fertilizers (91.7%), achieving better crop quality (81.0%), and building consumer trust (66.7%). Economic motivations include enhancing income opportunities (32.5%), following government recommendations (31.3%), and meeting high consumer demand (31.3%).

Farmers identified numerous benefits of ECA, particularly its ability to enhance soil health (95.2%), safeguard water resources (94.8%), and protect biodiversity (89.7%). ECA is also credited with improving crop quality (84.5%), attracting visitors to Ifugao (82.9%), and mitigating the effects of climate change (79.0%). Additional benefits include supporting local industries (75.4%), boosting groundwater levels (57.5%), reducing the risks of flooding and drought (57.1%), and increasing farming income (52.4%).

Beyond its environmental contributions, farmers recognize ECA's broader societal and economic benefits. Most respondents (88.5%) agree that ECA strengthens tourism in Ifugao, while 81.4% believe it empowers youth, women, and the elderly in the community. Additionally, 81.8% agree that ECA supports the Sustainable Development Goals (SDGs), and 89.7% view it as economically, socially, and environmentally sustainable. Many farmers (91.2%) feel that ECA improves their quality of life, and 76.2% see it as a tool to strengthen the economy of Ifugao. However, fewer respondents (73.8%) agree that ECA helps reinforce local organizations, with 25.4% uncertain about this aspect.

Overall, the findings illustrate strong support for ECA practices among farmers, highlighting its perceived effectiveness in mitigating climate change, promoting sustainability, and improving livelihoods. However, the areas of uncertainty suggest opportunities for further education and support to maximize ECA's benefits across Ifugao's farming communities.

3.3. Relationships Between Socio-Demographic and Farm-Related Factors and ECA Continuation

The findings identify key factors influencing farmers' continuation of Environmental Conservation Agriculture (ECA), providing critical insights into the economic, social, cultural, and environmental dynamics shaping adoption (Tables 1–3). Farmers' reliance on financial resources and agricultural inputs significantly affects their likelihood of continuing ECA. For instance, farmers who avoid chemical inputs are 0.53 times more likely to continue ECA. Additionally, farmers who perceive drought as a significant challenge are 1.7 times more likely to adopt ECA, underscoring its perceived effectiveness in water management and drought mitigation. Access to high-yielding seeds is another critical factor; farmers with limited access to these seeds are 54% less likely to continue ECA, highlighting the need for productive inputs to sustain conservation practices. Similarly, financial support plays a pivotal role, with farmers who depend on loans from individual moneylenders or lending institutions being nearly twice as likely to adopt ECA, emphasizing the necessity of accessible credit systems for sustainable farming.

Income diversification, or having other sources of income aside from farming, also influences ECA adoption. Farmers engaged in handicraft sales are 4.7 times more likely to continue ECA, likely because their supplemental income supports their farming activities. Conversely, a reliance on tourism-related income and remittances decreases the likelihood of adoption by 35% and 39%, respectively, suggesting that alternative income sources may reduce the dependence on farming and conservation practices. Market access further impacts adoption; farmers who sell directly to consumers are three times more likely to continue ECA, benefiting from higher profit margins, while reliance on middlemen decreases adoption likelihood by 62%. These findings emphasize the economic incentives and challenges linked to sustaining conservation agriculture.

Water management and resource needs are also crucial in determining ECA continuation. Farmers who recognize irrigation as essential are 3.7 times more likely to continue ECA, reflecting the importance of addressing water management issues in agricultural practices. Conversely, farmers who perceive a need for equipment are 48% less likely to adopt ECA, possibly due to challenges in accessing or maintaining the modern tools necessary for conservation. Access to drought-resistant crops presents another barrier, as farmers who consider these crops important are 46% less likely to continue ECA, likely due to difficulties in obtaining or effectively utilizing them. Interestingly, farmers who prioritize minimizing expenses are 2.00 times more likely to continue ECA. This suggests that ECA may be perceived as a cost-effective approach by reducing the reliance on expensive chemical inputs or by leveraging organic alternatives that align with the principles of sustainable farming.

Table 1. Relationships of socio-demographic and farm-related factors with farmers' ECA continuation in the rice terrace clusters of Banaue, Ifugao.

Predictor	Estimate	Odds Ratio	Significance
ECA methods being used [a]			
Uses organic fertilizer	−0.265	0.77	0.243
Uses organic pesticides	0.093	1.10	0.618
Not using chemical pesticides or fertilizers	0.633	0.53	0.002 **
Crop rotation	−0.257	0.77	0.228
Composting	0.185	1.20	0.596
Indigenous pest management	−0.187	0.83	0.492
Challenges faced in farming [b]	−0.031	0.97	0.916
Drought and water scarcity	0.538	1.71	0.002 **
Insufficient income	0.727	2.07	0.296
Low crop yields	0.231	1.26	0.501
Limited irrigation facilities	0.015	1.02	0.945
Shortage of labor	0.216	1.24	0.366
Lack of access to high-yielding crop varieties	−0.767	0.46	0.009 **
Insufficient farming equipment or work animals (i.e., carabaos)	0.200	1.22	0.525
Soil erosion and land degradation	−0.031	0.97	0.916
Sources of farming capital [c]			
Loans from individual moneylenders or fellow farmers	0.676	1.97	0.007 **
Financial support from relatives or friends	−0.076	0.93	0.675
Personal savings or own funds	−0.033	0.97	0.93
Loans from lending institutions or banks	0.680	1.97	0.037 *
Sources of income aside from farming [d]			
Woodcarving and craftsmanship	−0.877	0.42	0.125
Selling handicrafts or artisan goods	1.544	4.68	0.019 *
Tourism-related activities	−0.437	0.65	0.017 *
Remittances from relatives working abroad or outside Ifugao	−0.489	0.61	0.006 **
Support needed for farming [e]			
Access to high-yielding seed varieties	0.047	1.05	0.829
Improved irrigation facilities and assistance	1.312	3.71	0.020 *
Solutions for managing soil erosion	−0.181	0.83	0.669
Availability of modern machineries or carabaos	−0.646	0.52	0.021 *
Opportunities for diversified income sources	−0.360	0.70	0.206
Fair and competitive price for harvested crops	0.212	1.24	0.244
Selling place for harvested crops [f]			
Direct to consumer	1.101	3.01	0.000 **
Public market	0.12	1.13	0.749
Trader or middleman	−0.977	0.38	0.042 *
Self-consumption	−0.54	0.58	0.358
Important considerations for farming [g]			
Maximizing income and crop yields	0.151	1.16	0.519
Access to financial support	0.212	1.24	0.413
Minimizing expenses	0.695	2.00	0.016 *
Reliable seed supplies	−0.118	0.89	0.587
Use of pest-resistant crop varieties	−0.42	0.66	0.095
Ensuring high crop quality	−0.159	0.85	0.576
Planting drought-resistant crop varieties	−0.609	0.54	0.034 *
Learning from the success of other farmers	−0.643	0.53	0.051
Maintaining strong relationships with other farmers (i.e., camaraderie)	0.215	1.24	0.606
Achieving peace of mind	0.207	1.23	0.633

Table 1. *Cont.*

Predictor	Estimate	Odds Ratio	Significance
Sources of information in farming [h]			
Seed suppliers or traders	−0.208	0.81	0.53
Agricultural technicians	0.066	1.07	0.738
Co-farmers	0.163	1.18	0.756
Barangay officials	1.542	4.67	0.000 **
Motivators to adopt ECA [i]			
Co-farmers	−0.043	0.96	0.814
Farmer leaders	1.296	3.65	0.000 **
Information seen/heard from media sources	−0.580	0.56	0.005 **
Family or ancestors	0.248	1.28	0.197

* Significant at $p < 0.05$. ** Significant at $p < 0.01$. [a] Link function: complementary log-log f(x) = log(−log(1 − x)); goodness-of-fit pseudo R-square Cox and Snell: 0.079; Nagelkerke: 0.086; McFadden: 0.033; test of parallel lines: Chi-square = 39.298, df = 18, sig = 0.248; model fit: Chi-square = 20.793, df = 6, sig = 0.003. [b] Link function: complementary log-log f(x) = log(−log(1 − x)); goodness-of-fit pseudo R-square Cox and Snell: 0.071; Nagelkerke: 0.077; McFadden: 0.029; test of parallel lines: Chi-square = 28.649, df = 24, sig = 0.234; model fit: Chi-square = 18.507, df = 8, sig = 0.018. [c] Link function: complementary log-log f(x) = log(−log(1 − x)); goodness-of-fit pseudo R-square Cox and Snell: 0.056; Nagelkerke: 0.061; McFadden: 0.023; test of parallel lines: Chi-square = 15.297, df = 12, sig = 0.226; model fit: Chi-square = 14.558, df = 4, sig = 0.006. [d] Link function: complementary log-log f(x) = log(−log(1 − x)); goodness-of-fit pseudo R-square Cox and Snell: 0.071; Nagelkerke: 0.078; McFadden: 0.030; test of parallel lines: Chi-square = 11.605, df = 12, sig = 0.478; model fit: Chi-square = 18.694, df = 4, sig = 0.001. [e] Link function: complementary log-log f(x) = log(−log(1 − x)); goodness-of-fit pseudo R-square Cox and Snell: 0.048; Nagelkerke: 0.052; McFadden: 0.020; test of parallel lines: Chi-square = 27.807, df = 18, sig = 0.165; model fit: Chi-square = 12.412, df = 6, sig = 0.003. [f] Link function: complementary log-log f(x) = log(−log(1 − x)); goodness-of-fit pseudo R-square Cox and Snell: 0.161; Nagelkerke: 0.175; McFadden: 0.070; test of parallel lines: Chi-square = 19.562, df = 12, sig = 0.176; model fit: Chi-square = 44.235, df = 4, sig = 0.000. [g] Link function: complementary log-log f(x) = log(−log(1 − x)); goodness-of-fit pseudo R-square Cox and Snell: 0.121; Nagelkerke: 0.131; McFadden: 0.051; test of parallel lines: Chi-square = 22.583, df = 30, sig = 0.832; model fit: Chi-square = 32.417, df = 10, sig = 0.000. [h] Link function: complementary log-log f(x) = log(−log(1 − x)); goodness-of-fit pseudo R-square Cox and Snell: 0.174; Nagelkerke: 0.189; McFadden: 0.076; test of parallel lines: Chi-square = 18.846, df = 12, sig = 0.192; model fit: Chi-square = 48.078, df = 4, sig = 0.000. [i] Link function: complementary log-log f(x) = log(−log(1 − x)); goodness-of-fit pseudo R-square Cox and Snell: 0.158; Nagelkerke: 0.172; McFadden: 0.069; test of parallel lines: Chi-square = 53.356, df = 12, sig = 0.175; model fit: Chi-square = 43.446, df = 4, sig = 0.000.

Table 2. Spearman's correlation analyses between socio-demographic, farm-related, ECA-related, and climate change-related variables and ECA continuation by farmers in Banaue, Ifugao.

Variable	Correlation Coefficient	Significance
Farming experience	0.126 *	0.045
Rituals are helpful in farming	−0.301 **	0.000
Interest in ECA	0.385 **	0.000
Climate change affects farming in Ifugao	0.182 **	0.000
Subsidies are helpful in farming	0.155 *	0.014
ECA helps mitigate climate change	0.159 *	0.012
ECA helps strengthen tourism in Ifugao	0.428 **	0.000
ECA helps strengthen the youth, women, and elderly in Ifugao	0.416 **	0.000
ECA is economically, socially, and environmentally sustainable	0.225 **	0.000
ECA helps strengthen the economy of Ifugao	0.405 **	0.000
ECA helps improve the lives of farmers in Ifugao	0.243 **	0.000
ECA helps strengthen local organizations in Ifugao	0.305 **	0.000

* Significant at $p < 0.05$; ** significant at $p < 0.01$.

Social and cultural factors play significant roles in influencing ECA adoption. Community-based guidance, particularly from barangay officials and farmer leaders, strongly affects continuation, with farmers who receive information from barangay officials being 4.67 times more likely to adopt ECA, and those guided by farmer leaders 3.65 times more likely. In contrast, farmers influenced by the media are 44% less likely to continue ECA, potentially reflecting distrust in media sources or the limited relevance of general information compared to localized and specific guidance. Cultural practices present additional challenges, as farmers adhering to traditional farming rituals are less likely to adopt ECA, indicating a potential conflict between ritual-based and modern conservation practices. Addressing these cultural barriers will be essential to bridging traditional practices with sustainable agricultural methods.

Table 3. Correlation analyses between farm-related data and ECA continuation by farmers in Banaue, Ifugao.

Variable	Test	Statistic	Significance
Member of an agricultural organization	Pearson's Chi-square	25.809 **	0.000
	Phi and Cramer's V	0.320 **	0.000
Have rituals in farming	Pearson's Chi-square	−24.024 **	0.000
	Phi and Cramer's V	−0.309 **	0.000
Planting other rice varieties aside from *Tinawon*	Pearson's Chi-square	16.445 **	0.002
	Phi and Cramer's V	0.256 **	0.002

** significant at $p < 0.01$.

Intrinsic motivations and the perceived benefits of ECA strongly drive its adoption. Farmers who view ECA as mitigating climate change or empowering marginalized groups, such as youth, women, and the elderly, are significantly more likely to continue its practices. Additionally, ECA's perceived contributions to strengthening local economies, improving livelihoods, and supporting community organizations act as strong motivators for adoption. Interest in ECA correlates strongly with its continuation, emphasizing the importance of fostering enthusiasm for conservation practices. Farmers who perceive that climate change impacts farming and who see subsidies as helpful also show higher rates of adoption, though these external factors appear secondary to intrinsic motivations and perceived community-level benefits.

Membership in agricultural organizations is another important factor, showing a moderate positive association with ECA continuation. Membership provides access to resources, knowledge, and collective support, all of which encourage the adoption and maintenance of conservation practices. Diversification of crops, such as planting rice varieties other than Tinawon, also shows a positive association with ECA, albeit to a lesser extent. This suggests that introducing complementary or resilient crops aligns with sustainable agricultural practices, potentially enhancing the resilience of farming systems.

The findings emphasize the multifaceted nature of ECA adoption, highlighting the centrality of economic, environmental, and social factors in influencing continuation. Financial incentives, such as access to loans, productive inputs, and direct market channels, play a pivotal role in motivating adoption, while environmental considerations, such as improved water management, also drive interest. Community-level support, particularly from local officials and farmer leaders, significantly shapes decision-making, while broader media campaigns are less effective. Cultural practices, including the reliance on rituals, present barriers that need to be addressed by promoting compatibility between traditional and modern conservation methods. Programs aiming to enhance ECA adoption should prioritize providing financial resources, facilitating access to essential agricultural inputs, promoting localized guidance, and fostering intrinsic motivations by emphasizing the economic, environmental, and social benefits of ECA. By addressing these factors, the adoption of sustainable agricultural practices can be effectively supported, enhancing the resilience and livelihoods of farming communities.

3.4. Relationships Between ECA-Related and Climate Change-Related Factors and ECA Continuation

Farmers who perceive flooding as a climate change effect are 1.5 times more likely to continue ECA, suggesting that the threat of flooding motivates them to adopt conservation strategies (Table 4). In contrast, farmers who perceive extreme heat as a significant challenge are 52% less likely to continue ECA, indicating that heat-related conditions make it difficult to adapt conservation practices. Similarly, farmers who view seasonal shifts as a major challenge are 60% less likely to continue ECA, underscoring the difficulty of aligning conservation efforts with unpredictable seasonal changes.

Table 4. Relationships of ECA-related and climate change-related factors with farmers' ECA continuation in the rice terrace clusters of Banaue, Ifugao.

Predictor	Estimate	Odds Ratio	Significance
Perceived effects of climate change [a]			
Flooding	0.404	1.50	0.026 *
Landslides and soil erosion	0.617	1.85	0.324
Increasing temperatures or extreme heat	−0.728	0.48	0.017 *
Increased typhoon intensity or frequency	0.062	1.06	0.841
Changes in crop distribution	0.116	1.12	0.621
Shifts in seasonal patterns	−0.92	0.40	0.004 **
Sea level rise	−0.03	0.97	0.923
Drought	0.069	1.07	0.777
Damage to houses and infrastructure	0.36	1.43	0.054
Loss of arable land or farmland	0.443	1.56	0.108
Crop damage or loss	−0.171	0.84	0.631
Reasons for ECA continuation [b]			
To contribute to local and global environment protection	−0.609	0.54	0.094
To build and maintain consumer trust	0.781	2.18	0.000 **
To promote personal health and well-being	−0.333	0.72	0.488
To enhance income opportunities	0.634	1.89	0.009 **
To meet high consumer demand	0.056	1.06	0.809
To achieve better crop quality	−0.237	0.79	0.332
To minimize the use of chemical pesticides and fertilizers	−0.073	0.93	0.847
To follow government recommendations	−0.164	0.85	0.379
Effects of ECA on farming [c]			
Mitigates the effects of climate change	−0.182	0.83	0.425
Enhances soil health	−0.511	0.60	0.248
Protects and sustains biodiversity	−0.269	0.76	0.404
Safeguards water resources	−0.455	0.63	0.307
Boosts groundwater levels	0.505	1.66	0.009 **
Improves crop quality	0.058	1.06	0.818
Reduces the risk of severe flooding and drought	−0.411	0.66	0.043 *
Increases farming income	0.56	1.75	0.002 **
Supports and promotes local industries	0.312	1.37	0.156
Attracts people to visit and stay in Ifugao	−0.329	0.72	0.222

* Significant at $p < 0.05$. ** Significant at $p < 0.01$. [a] Link function: complementary log-log $f(x) = \log(-\log(1 - x))$; goodness-of-fit pseudo R-square Cox and Snell: 0.159; Nagelkerke: 0.173; McFadden: 0.069; test of parallel lines: Chi-square = 35.421, df = 33, sig = 0.355; model fit: Chi-square = 43.721, df = 11, sig = 0.000. [b] Link function: complementary log-log $f(x) = \log(-\log(1 - x))$; goodness-of-fit pseudo R-square Cox and Snell: 0.171; Nagelkerke: 0.186; McFadden: 0.075; test of parallel lines: Chi-square = 63.591, df = 24, sig = 0.337; model fit: Chi-square = 47.176, df = 8, sig = 0.000. [c] Link function: complementary log-log $f(x) = \log(-\log(1 - x))$; goodness-of-fit pseudo R-square Cox and Snell: 0.100; Nagelkerke: 0.109; McFadden: 0.042; test of parallel lines: Chi-square = 60.151, df = 30, sig = 0.436; model fit: Chi-square = 26.633, df = 10, sig = 0.003.

Economic incentives also play a crucial role in driving ECA adoption. Farmers who prioritize consumer trust are 2.18 times more likely to continue ECA, highlighting the importance of public perception in motivating conservation practices. Additionally, farmers are nearly 1.9 times more likely to continue ECA when it leads to financial benefits, emphasizing the significance of economic incentives in sustaining these practices.

Farmers who perceive ECA as beneficial for groundwater conservation and reducing the risk of severe flooding and drought are 1.66 and 0.66 times more likely to continue, indicating that improvements in water resources and addressing water-related challenges strongly motivate ECA adoption. However, those who perceive ECA as ineffective in reducing flooding or drought are 34% less likely to continue, suggesting that dissatisfaction with the expected outcomes of ECA can hinder its continuation. On the other hand, farmers who experience financial benefits are 1.75 times more likely to continue ECA, further reinforcing the importance of economic rewards in supporting conservation practices.

Overall, the results show that the decision to continue ECA is driven primarily by tangible benefits, such as financial gains and environmental outcomes like improved groundwater levels. Farmers are motivated by the perceived effects of climate change, like flooding, while challenges like extreme heat and seasonal shifts pose significant barriers to ECA adoption. The importance of building consumer trust is also evident, indicating that market-driven incentives play a key role in encouraging conservation practices.

The findings suggest that both economic and environmental factors are critical for the continuation of ECA. To enhance adoption rates, support programs should focus on addressing key challenges, such as heat adaptation and seasonal shifts, while emphasizing the economic and environmental benefits that resonate most with farmers.

4. Discussion

This study sought to explore the continuation of Environmental Conservation Agriculture (ECA) practices among farmers in the Ifugao Rice Terraces, focusing on the socio-demographic, environmental, and economic factors influencing their decisions. The findings from this research shed light on the interplay of these factors and their implications for the sustainability of the rice terraces. The results provide valuable insights into the motivations and challenges that drive ECA adoption, while also highlighting the roles of community dynamics, access to resources, and climate change as central factors shaping the agricultural practices of the Ifugao farmers. Below are the key findings that emerged from our study, which we have also integrated with our theoretical frameworks.

(a) Economic Factors and Resource Access as Key Determinants of ECA Adoption

One of the most prominent findings in this study is the significant roles that economic factors and access to resources play in the adoption and continuation of ECA practices [28]. Farmers who have access to financial support, such as loans, and those who are able to obtain high-yielding seed varieties are more likely to continue practicing ECA. This aligns with the Sustainable Livelihoods Framework (SLF), which emphasizes the importance of various forms of capital—particularly financial capital and physical capital—in shaping farmers' ability to pursue sustainable livelihoods [22,29]. However, this study revealed limitations in the availability and equitable distribution of these resources, which has resulted in unequal access among farmers. These disparities underscore the challenges in ensuring the inclusivity of ECA programs, particularly for smallholder and marginalized farmers. In the context of Ifugao farmers, the reliance on financial resources (such as loans) or supplementary income (e.g., from handicrafts) highlights how economic pressures influence farmers' ability to maintain ECA practices. As many farmers depend on subsistence farming, which generates limited income, the need for additional financial resources is critical to support their agricultural endeavors [30].

The findings emphasize the multifaceted nature of ECA adoption, highlighting the centrality of economic, environmental, and social factors in influencing continuation [31]. Financial incentives, such as access to loans, productive inputs, and direct market channels, play a pivotal role in motivating adoption. Furthermore, this study found that farmers with limited access to high-yielding crop varieties or modern farming equipment were less likely to continue ECA. This finding underscores the Ecological Modernization Theory (EMT), which suggests that modern technological advancements—such as the adoption of improved irrigation systems and drought-resistant crops—can complement traditional agricultural techniques to increase productivity and environmental resilience [24,32]. A lack of access to such technological resources can hinder the integration of modern environmental conservation practices, which limits the farmers' ability to adapt to climate change and sustain ecological balance [33].

(b) Environmental Challenges and Climate Change Adaptation

This research revealed that climate change is a significant concern for Ifugao farmers, with the majority perceiving its impacts on their farming practices [3]. Farmers reported facing climate-induced challenges such as an increased typhoon intensity, changes in rainfall patterns, and soil erosion, all of which threaten agricultural productivity. A limitation of the current adaptation efforts is that they are largely reactive and lack long-term planning and institutional support. This shortfall limits the ability of farmers to fully integrate sustainable practices into their climate resilience strategies. Despite these limitations, they have adopted various adaptive strategies, including adjusting planting schedules, planting drought-resistant varieties, and strengthening water management practices. These adaptive strategies are in line with the core tenets of Resilience Theory, which emphasizes the capacity of agricultural systems to absorb disturbances, adapt to change, and transform to ensure long-term sustainability [26,34].

Resilience Theory is particularly relevant in understanding how Ifugao farmers have coped with the challenges posed by climate change [35]. By diversifying crops, using traditional soil conservation methods, and integrating modern techniques, the farmers have demonstrated an ability to adapt to the fluctuating environmental conditions. The integration of these adaptive strategies with sustainable farming practices under the framework of ECA highlights how resilience can be built through a combination of traditional knowledge and modern innovations. The perceived benefits of ECA—such as improved soil health, water conservation, and biodiversity protection—serve as mechanisms for building resilience in the agricultural systems of Ifugao, ensuring that farmers can continue to grow crops despite the environmental challenges they face [20].

(c) Community Support and Social Capital

A significant finding of this study is the role of community support in sustaining ECA practices [36]. Farmers who receive guidance from local agricultural leaders or barangay officials were significantly more likely to continue practicing ECA. This supports the Sustainable Livelihoods Framework (SLF), which stresses the importance of social capital—community networks, social relations, and collective resources—in achieving sustainable livelihoods [22]. However, this study also highlights a limitation in the reliance on informal community networks, which may lack the capacity to address broader structural issues, such as market access, resource constraints, and climate adaptation. In Ifugao, strong community ties and networks facilitate the exchange of agricultural knowledge, resource-sharing, and support for ECA practices. These community connections also help farmers adapt to climate-induced challenges, providing a sense of solidarity and shared responsibility for maintaining sustainable agricultural practices [37].

Interestingly, this study also found that the media influence was less effective in encouraging ECA adoption, suggesting that localized guidance from trusted community members is far more impactful than generic information from broader media sources. This finding emphasizes the importance of community-driven initiatives in promoting sustainable agriculture [17,38]. By fostering stronger local organizations and networks, stakeholders can ensure that the knowledge and support necessary for the continuation of ECA practices are available at the grassroots level.

(d) Cultural Practices and Their Influence on ECA Adoption

Another crucial theme emerging from the findings is the tension between traditional cultural practices and the adoption of modern conservation methods [39]. Many farmers continue to follow traditional farming rituals, which remain central to their agricultural practices. However, this study revealed that adherence to these rituals is inversely related to the adoption of ECA practices. This suggests that the deep-rooted cultural values and beliefs that shape farming practices may sometimes create barriers to the integration of modern agricultural practices. The tension highlights a limitation of current ECA programs, which often fail to account for the cultural dimensions of farming practices. Without integrating cultural considerations, the programs risk alienating farmers and reducing adoption rates [40].

The findings indicate the need to address barriers by promoting compatibility between traditional and modern conservation methods [41]. The conflict between traditional and modern practices underscores the relevance of Ecological Modernization Theory (EMT), which suggests that modern environmental practices can coexist with traditional farming systems if they are integrated thoughtfully [24,42]. In Ifugao, the challenge lies in bridging these two approaches to farming. A key opportunity for promoting ECA lies in integrating indigenous knowledge with contemporary conservation techniques, respecting cultural values while introducing innovations that enhance productivity and environmental sustainability [43]. Programs that facilitate this integration—through community dialogues or farmer-led workshops—could help mitigate the cultural barriers that hinder the widespread adoption of ECA.

(e) Economic Benefits and the Role of Market Access

Economic motivations play a significant role in driving the continuation of ECA practices [44,45]. Farmers who perceive the benefits of ECA, such as improved crop quality, increased consumer trust, and enhanced environmental outcomes, are more likely to continue practicing it. This study also revealed that farmers with direct access to markets were more likely to continue ECA, suggesting that economic incentives tied to market access are a crucial driver for the adoption of sustainable practices. Nonetheless, market access limitations, including logistical challenges, inadequate infrastructure, and a lack of market linkages, hinder farmers' ability to maximize the economic benefits of ECA practices. This finding aligns with both Sustainable Livelihoods Framework (SLF) and Ecological Modernization Theory (EMT), which highlight the importance of economic incentives and market-driven approaches in promoting sustainable practices [22,24]. Farmers who can sell directly to consumers, bypassing intermediaries, are better able to reap the financial rewards of their sustainable agricultural efforts, creating an economic incentive for maintaining ECA.

Programs aiming to enhance ECA adoption should prioritize providing financial resources, facilitating access to essential agricultural inputs, promoting localized guidance, and fostering intrinsic motivations by emphasizing the economic, environmental, and social benefits of ECA [44]. By addressing these factors, the adoption of sustainable agricultural practices can be effectively supported, enhancing the resilience and livelihoods of farming communities.

Furthermore, the perceptions of ECA as a means of increasing income, improving water resources, and reducing the environmental impact of farming are powerful motivators [46]. While financial incentives such as government subsidies are helpful, the broader economic benefits of ECA—including its contributions to local tourism and food security—serve as compelling reasons for farmers to continue adopting and refining these practices.

5. Conclusions and Recommendations

The continuation of Environmental Conservation Agriculture (ECA) practices among Ifugao farmers is influenced by a complex interplay of economic, social, environmental, and cultural factors. This study highlights the significant role of access to resources, such as high-yielding variety seeds, modern farming equipment, and financial support, in facilitating the adoption of ECA practices. Farmers with better access to these resources are more likely to continue ECA, whereas those facing resource constraints, such as limited irrigation facilities and drought-resistant crops, are less likely to sustain these practices. Economic incentives, including access to direct markets and supplementary income sources like handicrafts, also play a pivotal role, as market linkages provide better economic returns and enhance the viability of sustainable farming. Conversely, a reliance on intermediaries and an insufficient market infrastructure diminish the economic benefits of ECA, underscoring the need for targeted interventions to bridge these gaps, particularly for smallholder and marginalized farmers.

Environmental challenges and climate change have emerged as both motivators and deterrents to ECA adoption. Farmers recognize ECA's effectiveness in mitigating the impacts of climate change, such as soil erosion and water scarcity, which are critical for the ecological stability of the rice terraces. However, extreme heat and unpredictable seasonal shifts remain significant barriers, revealing the necessity for adaptive support systems and innovative solutions to help farmers manage these challenges. This study also reveals a tension between traditional cultural practices and modern conservation techniques, as adherence to traditional farming rituals is inversely related to ECA adoption. This highlights the need for culturally sensitive approaches that integrate indigenous knowledge with contemporary methods, ensuring compatibility while enhancing productivity and sustainability. Programs that promote dialogue and collaboration between farmers and conservation advocates can facilitate the coexistence of these approaches, preserving heritage while advancing agricultural innovation.

The findings underscore the importance of community support in sustaining ECA practices. Farmers who receive guidance from barangay officials or local agricultural leaders are more likely to continue ECA, reflecting the critical role of localized, trust-based networks in fostering sustainable agriculture. However, this study finds that broader media campaigns are less effective in driving adoption, suggesting that localized and community-driven initiatives are better suited to address the specific needs of farmers in Ifugao. Furthermore, ECA practices are shown to contribute significantly to the sustainability of the Batad and Bangaan rice terrace clusters in Banaue by addressing site-specific challenges, such as mitigating soil erosion and improving water management. These benefits extend beyond environmental conservation, as ECA also strengthens local tourism, empowers marginalized groups, and fosters economic resilience. By aligning ECA with the Sustainable Development Goals, stakeholders can amplify its role in promoting food security, poverty alleviation, and climate resilience in the region.

To ensure the sustained adoption of ECA, there is a need to improve access to financial resources, modern farming tools, and drought-resistant crops through targeted subsidies, grants, and credit programs tailored to the needs of farmers. Strengthening local organizations and networks through training and capacity-building initiatives can further enhance farmers' resilience and adaptability. Addressing cultural tensions by integrating traditional and modern practices can help bridge the gap between heritage and innovation, creating a holistic approach to agricultural sustainability. Improving market access and infrastructure to facilitate direct-to-consumer sales will provide better economic returns for farmers, reducing the reliance on intermediaries and enhancing the profitability of sustainable practices. Additionally, adaptive strategies, such as the introduction of improved irrigation systems, planting calendars, and diversified crop options, can help farmers better cope with the impacts of climate change.

Future research could explore the long-term impacts of ECA adoption and assess how cultural, economic, and environmental factors evolve over time in shaping sustainable agricultural practices in heritage sites like the Ifugao Rice Terraces. Examining the roles of education, gender dynamics, and generational shifts in influencing ECA adoption can further inform targeted policy interventions. Investigating innovative models that integrate tourism and agriculture may also unlock new opportunities for economic growth while preserving cultural and environmental heritage. By addressing these areas, ECA can fully realize its transformative potential to sustain the ecological and socio-economic integrity of the Ifugao Rice Terraces, ensuring the resilience and prosperity of its farming communities for generations to come.

Supplementary Materials: The following supporting information can be downloaded at https://www.mdpi.com/article/10.3390/agriculture15030246/s1: Supplementary Table S1. Socio-demographic and farm-related data of the ECA farmers in the rice terrace clusters of Banaue, Ifugao; Supplementary Table S2. ECA- and climate change-related factors of the ECA farmers in the rice terrace clusters of Banaue, Ifugao.

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References

1. Food and Agriculture Organization of the United Nations. *Globally Important Agricultural Heritage Systems: Combining Agricultural Biodiversity, Resilient Ecosystems, Traditional Farming Practices and Cultural Identity*; Food and Agriculture Organization of the United Nations: Rome, Italy, 2018.
2. Bantayan, N.; Calderon, M.; Dizon, J.; Sajise, A.; Salvador, M. Estimating the Extent and Damage of the UNESCO World Heritage Sites of the Ifugao Rice Terraces, Philippines. *J. Environ. Sci. Manag.* **2012**, *15*, 1–5.

3. Soriano, M.; Diwa, J.; Herath, S. Local perceptions of climate change and adaptation needs in the Ifugao Rice Terraces (Northern Philippines). *J. Mt. Sci.* **2017**, *14*, 1455–1472. [CrossRef]
4. Dulnuan, E.D. The Ifugao Rice Terraces Tourism: Status, Problems, Concerns. *Int. J. Ecol. Conserv.* **2014**, *10*, 19–31. [CrossRef]
5. Koohafkan, P.; Altieri, M. *Globally Important Agricultural Heritage Systems–A Legacy for the Future*; Food and Agriculture Organization of the United Nations: Rome, Italy, 2010.
6. Maharjan, K.L.; Gonzalvo, C.M.; Aala, W.F. Drivers of Environmental Conservation Agriculture in Sado Island, Niigata Prefecture, Japan. *Sustainability* **2022**, *14*, 9881. [CrossRef]
7. Luo, L.; Qin, L.; Wang, Y.; Wang, Q. Environmentally-friendly agricultural practices and their acceptance by smallholder farmers in China-A case study in Xinxiang County, Henan Province. *Sci. Total Environ.* **2016**, *571*, 737–743. [CrossRef]
8. Maharjan, K.L.; Gonzalvo, C.; Aala, W. Dynamics of Environmental Conservation Agriculture (ECA) Utilization among Fujioka Farmers in Japan with High Biodiversity Conservation Awareness but Low ECA Interest. *Sustainability* **2022**, *14*, 5296. [CrossRef]
9. MAFF. *Summary of the Annual Report on Food, Agriculture and Rural Areas in Japan*; MAFF: Tokyo, Japan, 2020.
10. Magcale-Macandog, D.; Ocampo, L. Indigenous strategies of sustainable farming systems in the highlands of northern Philippines. *J. Sustain. Agric.* **2005**, *26*, 117–138. [CrossRef]
11. Joshi, R.; Matchoc, O.; Bahatan, R.; Dela Peña, F. Farmers' knowledge, attitudes and practices of rice crop and pest management at Ifugao Rice Terraces, Philippines. *Int. J. Pest Manag.* **2000**, *46*, 43–48. [CrossRef]
12. Rovillos, R.D.; Dacquigan, F.A.; Florido, R.S.; Baggo, J.C.; Pumihic, C.B.; Pawid, L.C.I.; Kindipan-Nabokiag, N.L.; Ta-a, J.J.A.; Bilibli, A.D. *The Ifugao Rice Terraces Master Development Plan (2015–2024): A Mid-Term Review*; Ifugao State University: Lamut, Philippines, 2024.
13. Avtar, R.; Tsusaka, K.; Herath, S. REDD+ Implementation in Community-Based Muyong Forest Management in Ifugao, Philippines. *Land* **2019**, *8*, 164. [CrossRef]
14. Manandhar, S.; Vogt, D.S.; Perret, S.R.; Kazama, F. Adapting cropping systems to climate change in Nepal: A cross-regional study of farmers' perception and practices. *Reg. Environ. Change* **2011**, *11*, 335–348. [CrossRef]
15. Mendelsohn, R.; Dinar, A. Climate Change, Agriculture, and Developing Countries: Does Adaptation Matter? *World Bank Res. Obs.* **1999**, *14*, 277–293. [CrossRef]
16. Maharjan, K.L.; Singh, M.; Gonzalvo, C.M. Drivers of environmental conservation agriculture and women farmer empowerment in Namobuddha municipality, Nepal. *J. Agric. Food Res.* **2023**, *13*, 100631. [CrossRef]
17. Brodt, S.; Feenstra, G.; Kozloff, R.; Klonsky, K.; Tourte, L. Farmer-community connections and the future of ecological agriculture in California. *Agric. Hum. Values* **2006**, *23*, 75–88. [CrossRef]
18. Lopez-Maldonado, Y.; Berkes, F. Restoring the environment, revitalizing the culture: Cenote conservation in Yucatan, Mexico. *Ecol. Soc.* **2017**, *22*, 7. [CrossRef]
19. Delian, E.; Chira, A.; Badea, M.; Chira, L. Sustainable Agriculture Systems to Mitigate Climate Change Effects: A Brief Overview. *Sci. Pap. Ser. Manag. Econ. Eng. Agric. Rural. Dev.* **2019**, *19*, 127–134.
20. El Chami, D.; Daccache, A.; El Moujabber, M. How Can Sustainable Agriculture Increase Climate Resilience? *A Systematic Review. Sustainability* **2020**, *12*, 3119. [CrossRef]
21. Maharjan, K.; Gonzalvo, C.; Singh, M. Farmer Perspectives on the Economic, Environmental, and Social Sustainability of Environmental Conservation Agriculture (ECA) in Namobuddha Municipality, Kavre, Nepal. *Sustainability* **2024**, *16*, 4523. [CrossRef]
22. Natarajan, N.; Newsham, A.; Rigg, J.; Suhardiman, D. A sustainable livelihoods framework for the 21st century. *World Dev.* **2022**, *155*, 105898. [CrossRef]
23. Ehteshammajd, S.; Najafabadi, M.; Lashgarara, F.; Mirdamadi, S. Assessing Rural Household Food Security using Sustainable Livelihoods Framework in Western Iran. *Agric. Res.* **2023**, *12*, 232–246. [CrossRef]
24. Gibbs, D. Ecological Modernization. In *International Encyclopedia of Geography: People, the Earth, Environment and Technology*; Richardson, D., Castree, N., Goodchild, M.F., Kobayashi, A., Liu, W., Marston, R.A., Eds.; Wiley: Hoboken, NJ, USA, 2017.
25. Julkovski, D.; Sehnem, S.; Bennet, D.; Leseure, M. Ecological Modernization Theory (EMT): Antecedents and Successors. *Indones. J. Sustain. Account. Manag.* **2021**, *5*, 324–338. [CrossRef]
26. Wang, X.; Zhu, Q. Influencing Factors of Traditional Village Protection and Development from the Perspective of Resilience Theory. *Land* **2022**, *11*, 2314. [CrossRef]
27. Kelly, C.; Ferrara, A.; Wilson, G.; Ripullone, F.; Nolè, A.; Harmer, N.; Salvati, L. Community resilience and land degradation in forest and shrubland socio-ecological systems: Evidence from Gorgoglione, Basilicata, Italy. *Land Use Policy* **2015**, *46*, 11–20. [CrossRef]
28. Uziak, J.; Lorencowicz, E. Sustainable Agriculture—Developing Countries Perspective. In *Farm Machinery and Processes Management in Sustainable Agriculture*; Springer: Berlin/Heidelberg, Germany, 2017; pp. 389–394.

29. Xie, J.; Yang, G.; Wang, G.; Zhang, X. Sustainable land use in central China: The effects of different livelihood capital configurations on farmers' ecological production behaviors. In *Environment Development and Sustainability*; Springer: Berlin/Heidelberg, Germany, 2024. [CrossRef]
30. Bisht, I.; Pandravada, S.; Rana, J.; Malik, S.; Singh, A.; Singh, P.; Ahmed, F.; Bansal, K. Subsistence Farming, Agrobiodiversity, and Sustainable Agriculture: A Case Study. *Agroecol. Sustain. Food Syst.* **2014**, *38*, 890–912. [CrossRef]
31. Sester, M.; Craheix, D.; Daudin, G.; Sirdey, N.; Scopel, E.; Angevin, F. Assessment of the sustainability of conservation agriculture cropping systems in Madagascar (Alaotra Lake) using MASC-Mada. *Cah. Agric.* **2015**, *24*, 123–133. [CrossRef]
32. Xing, Y.; Wang, X. Precision Agriculture and Water Conservation Strategies for Sustainable Crop Production in Arid Regions. *Plants* **2024**, *13*, 3184. [CrossRef]
33. Fita, A.; Rodríguez-Burruezo, A.; Boscaiu, M.; Prohens, J.; Vicente, O. Breeding and Domesticating Crops Adapted to Drought and Salinity: A New Paradigm for Increasing Food Production. *Front. Plant Sci.* **2015**, *6*, 978. [CrossRef]
34. Urruty, N.; Tailliez-Lefebvre, D.; Huyghe, C. Stability, robustness, vulnerability and resilience of agricultural systems. *A review. Agron. Sustain. Dev.* **2016**, *36*, 15. [CrossRef]
35. Darnhofer, I.; Fairweather, J.; Moller, H. Assessing a farm's sustainability: Insights from resilience thinking. *Int. J. Agric. Sustain.* **2010**, *8*, 186–198. [CrossRef]
36. Hussayn, J.; Gulak, D. Realizing Sustainable Food Systems Among Organic Farmers in Nigeria: Evidence from Community Supported Agriculture. *Sci. Pap. Ser. Manag. Econ. Eng. Agric. Rural. Dev.* **2020**, *20*, 267–273.
37. Jacobson, C. Community climate resilience in Cambodia. *Environ. Res.* **2020**, *186*, 109512. [CrossRef]
38. Kaponda, T.; Chiwaridzo, O.T. Empowering Smallholder Farmers Through Community-Based Marketing Initiatives in Promoting Sustainable Agriculture. In *Emerging Technologies and Marketing Strategies for Sustainable Agricultur*; Garwi, J., Masengu, R., Chiwaridzo, O.T., Eds.; IGI Global Scientific Publishing: Hershey, PA, USA, 2024; p. 27.
39. Faye, J. Indigenous farming transitions, sociocultural hybridity and sustainability in rural Senegal. *NJAS Wagening. J. Life Sci.* **2020**, *92*, 1–8. [CrossRef]
40. Fenetiruma, O.A.; Kamakaula, Y. Ecological and Cultural Balance in Traditional Agriculture: An Environmental Anthropological Approach. *Glob. Int. J. Innov. Res.* **2023**, *1*, 68–77. [CrossRef]
41. Gonzalvo, C.M.; Aala, W.J.F.; Maharjan, K.L. Farmer Decision-Making on the Concept of Coexistence: A Comparative Analysis between Organic and Biotech Farmers in the Philippines. *Agriculture* **2021**, *11*, 857. [CrossRef]
42. Sekhar, M.; Rastogi, M.; Rajesh, C.M.; Saikanth, D.R.K.; Rout, S.; Kumar, S.; Patel, A.K. Exploring Traditional Agricultural Techniques Integrated with Modern Farming for a Sustainable Future: A Review. *J. Sci. Res. Rep.* **2024**, *30*, 185–198. [CrossRef]
43. Limpo, S.; Fahmid, I.; Fattah, A.; Rauf, A.; Surmaini, E.; Muslimin; Saptana; Syahbuddin, H.; Andri, K. Integrating Indigenous and Scientific Knowledge for Decision Making of Rice Farming in South Sulawesi, Indonesia. *Sustainability* **2022**, *14*, 2952. [CrossRef]
44. Hilmi, Y.; Tóth, J.; Gabnai, Z.; Király, G.; Temesi, A. Farmers' resilience to climate change through the circular economy and sustainable agriculture: A review from developed and developing countries. *Renew. Agric. Food Syst.* **2024**, *39*, e15. [CrossRef]
45. Konfo, T.; Chabi, A.; Gero, A.; Lagnika, C.; Avlessi, F.; Biaou, G.; Sohounhloue, C. Recent climate-smart innovations in agrifood to enhance producer incomes through sustainable solutions. *J. Agric. Food Res.* **2024**, *15*, 100985. [CrossRef]
46. Hellin, J.; Fisher, E.; Taylor, M.; Bhasme, S.; Loboguerrero, A. Transformative adaptation: From climate-smart to climate-resilient agriculture. *Cabi Agric. Biosci.* **2023**, *4*, 30. [CrossRef]