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Article

Factors influencing environmental conservation agriculture (ECA) continuation in Sado Island, Niigata Prefecture, Japan

Keshav Lall Maharjan [1,*], Clarisse Mendoza Gonzalvo [1] and Wilson Jr. Florendo Aala [2]

[1] Graduate School of Humanities and Social Sciences, Hiroshima University, 1-1-1 Kagamiyama, Higashi-Hiroshima City 739-8524, Hiroshima, Japan; gonzalvo.clarisse@gmail.com
[2] Institute of Clinical Medicine, National Cheng Kung University, No. 1 University Road, Tainan 701, Taiwan; s98107020@gs.ncku.edu.tw
* Correspondence: mkeshav@hiroshima-u.ac.jp

Abstract: Sado Island in Niigata prefecture, Japan is one of the first Globally Important Agricultural Heritage Systems (GIAHS) among developed countries and has since been involved in environmental conservation agriculture (ECA). While ECA is still in its early stage in Japan, it has proven to be effective in mitigating climate change in the agricultural sector; hence, this study analyzed the factors which could contribute to the ECA continuation among Sado Island farmers. The data revealed the prevalence of farmers' cognitive dissonance between ECA and its mitigating effects on climate change. Exploratory factor analysis and ordinal regression confirmed the importance of perceived GIAHS involvement in the continuation of ECA. In addition, other identified factors affecting ECA continuation fall either on a macro-level (i.e., farmers' awareness of their role in improving their environment) or micro-level (i.e., farmers' differing farm optimizations). These perspectives highlighted the altruistic nature of the Sado Island ECA farmers by valuing the improvement of their local and global environment as their main reason to continue ECA, whereas their various farm management optimizations support this observed farmer altruism by providing avenues to increase yield with only a moderate paddy land area. This study thereby highlights the need to continuously develop sustainable strategies to maintain and improve a positive farmer mindset towards ECA.

Keywords: environmental conservation agriculture, Globally Important Agricultural Heritage Systems, climate change mitigation, *Tokimai* brand, Sado island, Japan, biodiversity conservation, sustainable agriculture

1. Introduction

Climate change is a global phenomenon and its irreversible effects on the agricultural sector and food security are evident in the world today. In previous centuries, the repercussions of the industrial revolution and modernization have led to the rapid increase of greenhouse gas (GHG) concentration, and since agriculture is strongly dependent on weather patterns, it will greatly be impacted by climate change [1]. The three determinants of food security are also affected, particularly availability, access, and utilization [2]. If not properly handled, this can contribute to severe yield losses and more challenges in feeding the surging global population, which can reach its 10th billion mark by 2050 and projects the need to produce 60% more food [3,4]. The Japan Ministry of Environment reported that for the fiscal year (FY) 2019, the total greenhouse gas emissions (GHGs) of Japan amounted to 1,212 million tons. By the end of the 21st century, it is predicted that Japan's annual mean temperature will increase by around 2 to 3°C in each region [5]. Japan's agriculture and food industries would be severely affected by the

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ongoing effects of climate change and this trend will cause long-term regional differences which can affect regional production activities. For example, one paper reported that climate change will increase rice production in Hokkaido and Tohoku prefectures while decreasing rice production in Kanto and its western region [6]. In order to avoid these negative consequences, Japan is targeting to be carbon neutral by 2050 through its Green Growth Strategy, which puts emphasis on carbon recycling and the next-generation solar cells [7]. These global and national scenarios emphasize the need to come up with viable solutions to mitigate the continuing effects of climate change, most especially in the agricultural sector.

One of Japan's main strategies to reduce its total emissions in agriculture is to support and promote environmental conservation agriculture (ECA), especially through direct payment subsidies. Since 1992, Japan has taken initiatives to promote ECA and sustainable farming nationwide, such as the provision of subsidies for agro-environmental conservation activities and direct payments to eco-friendly farmers [8]. In general, ECA is a type of agriculture that aims to conserve the natural environment. It is formally defined as *"sustainable agriculture, taking advantage of the material circulation function of agriculture, keeping in mind the harmony with productivity, that takes into consideration the reduction of environmental impact caused by the use of chemical fertilizers and pesticides through soil management"* [9]. In connection with the international movement to address climate change, ECA has been promoted not just in terms of chemical fertilizer and pesticide reduction, but also in biodiversity conservation [10]. With ECA's flexible scope, various forms of agricultural methods can fall under it, such as special farming (which uses 50-80% less pesticide and fertilizer than conventional farming), organic farming, and eco-farming (environmentally friendly methods based on other standards), which means that more farmers can be supported by the government. The promotion of ECA is important since almost 140,000 tons of GHGs are being reduced annually through activities that are being supported by ECA direct payments [11]. Furthermore, ECA diffusion can also improve the efficiency of farming in Japan and the structure of agriculture [12]. The continuation of ECA among current adopters should, therefore, be monitored and analyzed to ensure its sustained development. This paper attempts to contribute to this endeavor, specifically by exploring the factors affecting ECA continuation in Japan, particularly in Sado Island, Niigata prefecture – a globally important agricultural heritage system (GIAHS) and an area with high ECA adoption.

Effectiveness of ECA in preserving the Japanese crested ibises in Sado Island, Japan

Numerous studies have explored farmers' knowledge, attitude, and perception on climate change and its associated risks [13-17]. It can be observed that even if farmers are situated in the same geographical locations, they are not necessarily a uniform group of citizens performing similar decision-making processes, which means that their views on climate change also vary widely. Farmers also exhibit heterogeneity which influences their decisions at the individual, community, and national levels. In Japan, farmers' risk perceptions are greatly affected by their experiences and surrounding environments, which also impact their preferences and choices towards climate change adaptation and mitigation [18]. Furthermore, the willingness of Japanese farmers to participate in climate change adaptation measures is strongly determined by their preferences [19]. Hence, it is imperative to continue studying how farmers view their roles and responsibilities in these issues, which then affect the creation of future climate change policies for the agricultural sector.

Japan has been very active in the promotion of sustainable agriculture for several decades, of which the preservation of traditional farming, agro-culture, and biodiversity is highly valued. This enabled Japan's different prefectures to apply and get designated

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as Globally Important Agricultural Heritage Systems (GIAHS) [20]. The Food and Agriculture Organization of the United Nations (FAO) defined GIAHS as *"outstanding landscapes of aesthetic beauty that combine agricultural biodiversity, resilient ecosystems, and a valuable cultural heritage"*. The GIAHS sites provide livelihood and food security for millions of small-scale farmers globally and contribute to the production of sustainably produced goods and services [21]. FAO has designated 62 systems in 22 countries since 2005 and is currently reviewing 15 new proposals from eight different countries. At present, there are 11 sites designated as GIAHS in Japan. These are in the prefectures of Ishikawa, Niigata, Shizuoka, Kumamoto, Oita, Gifu, Wakayama, Miyazaki, Miyagi, and Tokushima [20]. This paper particularly focused on Sado Island in Niigata prefecture, one of the first GIAHS sites designated in a developed country.

Sado Island is around 855 km^2 with a total of 7,941.88 ha of cultivated land, of which 6,128.41 ha are rice-producing fields. Since 1960, Sado Island has been experiencing a sharp population decline, from 113,296 to 57,355 in 2015. There was also a decline in the number of farmers from 7,103 in 2010 to 5,927 in 2015, wherein 1,614 are those who produce food for self-consumption only [22]. This trend has been observed by Matanle (2008), of which the major causing factor of population decline is the outward migration of younger people to urban areas to look for better education and employment opportunities [23]. The island has *satoyama* and *satoumi* landscapes, the former term defined as *"landscapes that comprise a mosaic of different ecosystem types including secondary forests, agricultural lands, irrigation ponds, and grasslands, along with human settlements"* and the latter as *"Japan's coastal areas where human interaction over time has resulted in a high degree of productivity and biodiversity"* [24]. In particular, the *satoyama* landscape of Sado Island provides suitable habitats for the endangered Japanese crested ibises (i.e., *Nipponia nippon,* locally called *Toki* in Japanese) and Sado Island is famous for its rice produce with *Tokimai* brand, which supports the revival of the endangered *Toki* birds. Sethuraman et al. (2021) concur with this and reported that Sado Island's low-input rice system has successfully provided breeding grounds for the Toki birds, wherein more than 200 birds prey on small animals that cause rice production losses [25]. Farmers grow other agricultural crops like apples, oranges, pears, persimmons, cherries, strawberries, watermelons, shiitake mushrooms, among others, for self-consumption and extra income. In line with this, various contributions from the public and private sectors were given to support Sado Island's biodiversity preservation through ECA to breed, raise, and provide a habitat suitable for the release of *Toki* in the wild, which is a huge factor in its designation as a GIAHS.

In 2008, the "Sustainable Agriculture for Living Creature Project" was established in Japan, and this was evident on Sado Island. During this time, there was a 50% reduction in chemical pesticide and fertilizer input for around 77.6% of the Sado Island rice paddies; moreover, 25% of the total paddy fields were engaged with the project by 2012 [8]. One of the biggest reasons why ECA has been thoroughly adopted and implemented on the island is the preservation of the endangered Japanese crested ibises. The habitats of these birds are wetlands, and the paddy fields enable these species to thrive after being restored through extensive captive breeding programs. Local support was also received to improve the birds' feeding grounds, namely: reduction of chemical pesticide and fertilizer input by at least 50%; use of compost; making canals to connect nearby waterways/rivers and paddy fields for the free movement of fish/water animals; retaining water in the fallow paddy field in winter; making biotope for biodiversity; making a ditch to collect water during the dry season where living creatures survive; and conducting field surveys for species diversity in the field.

Sado Island was also able to obtain a rice certification with *Toki* branding in 2008 which enabled farmers to gain a reasonable profit for their harvest. It is interesting to note

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that rice produced in fields that provide habitat to birds has the highest price among rice brands that are produced in coexistence with living creatures [26]. Another important aspect of farmers' continuous ECA adoption is the community and government support. In terms of consumers' willingness to pay for eco-labeled rice, consumers in Osaka and Metropolitan areas were more willing to pay for the *Tokimai* brand than general consumers, most especially those who are concerned with safer cultivation methods and paddy field biodiversity [27]. Moreover, it was observed that consumers were willing to pay for the *Tokimai* rice brand to support the conservation efforts on Sado Island. It was also concluded in the report that the taste of rice should be emphasized to further boost its marketing.

The application of ECA for sustainable farming is very ideal; however, it still faces a lot of challenges such as: 1) aging of farmers and labor shortage; 2) technical issues (i.e., unstable yield and quality); 3) production costs; 4) low prices of agricultural products; 5) difficulty in securing sales channels or the lack of consumers' interest; and 6) wildlife damage, similar to challenges being faced by the agricultural sector in Japan. Along with these challenges, it is also vital to know how farmers perceive this farming method and what factors would influence their adoption or continuation. In line with this, this paper investigated the factors affecting farmers' ECA continuation and their possible implications. Moreover, this study focused on Sado Island in Niigata prefecture, which is a GIAHS, thereby producing recommendations on how ECA may possibly impact other GIAHS sites and ECA farmers as well.

2. Study Area and Methods

The study was conducted on Sado Island which is located west of the Niigata prefecture shoreline. It is the sixth-largest island in Japan which has a complex ecosystem, with interdependent *satoyama* and *satoumi* landscapes. The areas included in the study are Ryotsu, Aikawa, Sawata, Kanai, Niibo, Hatano, Mano, Akadomari, Hamochi, and Ogi, spanning northern, central, and southern Sado Island (Figure 1).

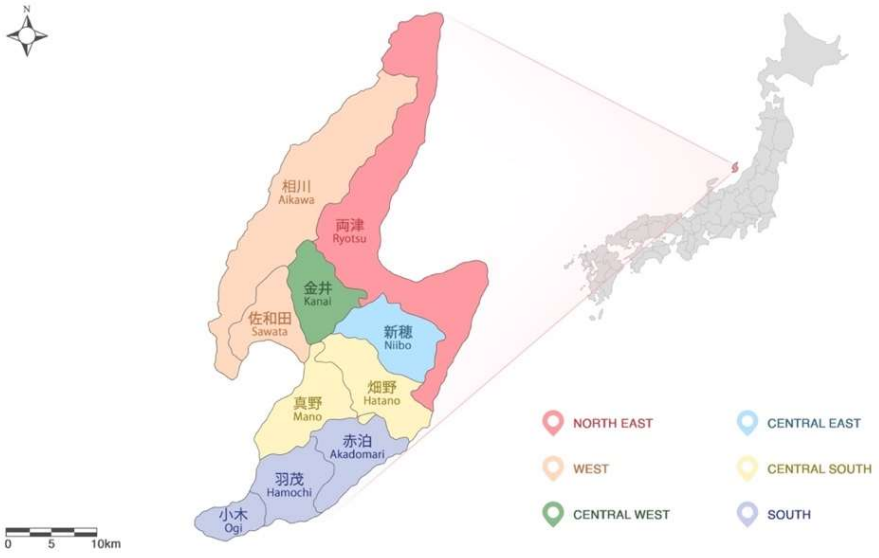

Figure 1. Map of Sado Island showing areas included in the study.

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A cross-sectional survey method was employed to collect data from ECA farmers on Sado Island. Key persons were consulted to grasp the situation and research context on the island, which aided in designing the aims of the study. In February 2020, the study's research objectives and questionnaire were first discussed in the annual meeting of the Board of Directors of the Council for Promotion of "*Toki-to-kurasu-satojukuri suishin kyogikai*" (Council for Promotion of Community Development Living with Toki), in cooperation with the Sado Island Municipality Agriculture Policy Division. The questionnaire was constructed by the research members of the joint research entitled, "Moving Towards Climate Change Resilient Agriculture: Understanding the Factors Influencing Adoption in India and Japan" in accordance with the rules of the Research Ethics Committee of Hiroshima University's Graduate School for International Development and Cooperation. The survey was conducted with informed consent and the respondents were assured that their identity and any information they will share will be kept private, securely stored, and will be used for research purposes only. The board approved the conduct of the survey and questionnaires were distributed to all the 415 council members, which essentially represent all the target farmers of the study in Sado Island. By the end of April 2020, 279 (67%) responses were sent back by the respondents. The contents of the questionnaire include: 1) basic information on farmers and agriculture; 2) opinion related to ECA; 3) perceptions and responses to climate change; 4) significance of ECA and its relationship to climate change; 5) practice of ECA and expectations on its effects; 6) ECA farmers' receiving of subsidy; and 7) prospects of Sado Island towards ECA. Questions related to ECA and climate change were adopted from MAFF [28-30].

To determine the effect of various factors on ECA continuation, factor analysis and ordinal logistic regression were employed, and the resulting model was verified using model fit, goodness-of-fit, and test of parallel lines in SPSS v.27. Additionally, multinomial logistic regression was used to determine the relationship between farmers' perceived level of climate change effects with the various effects of climate change.

3. Results

3.1. Environmental Conservation Agriculture (ECA) in Sado Island, Japan

Based on Japan's 2015 Agriculture and Forestry census, Sado Island has a total of 5,927 farmers, specifically comprising 4,313 commercial farmers and 1,614 farmers who produce food for self-consumption only [22]. There are 4,248 farm management entities, including farmers and companies holding 7,042 ha of land. Out of them, 4,204 are utilizing 6,128 ha of land to produce rice. The 415 council members of *Toki-to-kurasu-satojukuri suishin kyogikai* (Council for Promotion of Community Development Living with Toki) accounts for around 10% of the total commercial rice-producing farmers across Sado Island.

In this study, 77.4% of the farmers practice special farming using chemicals and pesticides less than 50% of the conventional farming on the island, 10.8% practice organic farming, 9.3% conduct eco-farming or other ECA-related methods, and 2.5% employ traditional methods (Table S1). This data agrees with the high number of farmers who reported a high interest in ECA (83.5%), intention to continue ECA (86.7%), and seek opportunities to learn about ECA (73.8%) (Table S2). Such data appears to reflect the permeating spread of ECA among the farmers. Chief among the farmers' reasons for continuing ECA is to build trust with customers (48.4%), followed by their aim to improve their local and global environment (40.9%), to supply better products (39.1%), and advised by Japan Agricultural Cooperatives or local government (31.5%). On the other hand, water management (65.6%), soil management (40.5%), change in planting time (38.7%), and

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ameliorating pest/disease (21.5%) are among the top adaptations that were being practiced by the farmers to circumvent the effects of climate change (Table 2). This agrees with earlier studies wherein water management, utilization of organic manure, crop rotation, and crop diversification were among the top ECA practices that were implemented in other countries [31,32]. Perceived levels of GIAHS involvement, enhancement of agricultural products/brand in Sado Island, effects on youth, and tourist promotion are also high at 43.7%, 59.1%, 38.7%, and 49.8% respectively. Interestingly, in a recurring island-wide survey on Sado Island regarding biodiversity and biodiversity-related information, roughly more than half of the respondents have replied that they have minimal to zero knowledge regarding the designation of Sado Island as a Globally Important Agricultural Heritage System (GIAHS) [33].

In terms of age, 61.3% of the farmers are at least 65 years old, while sex distribution in Sado Island farming households remains male dominant as is reported in other studies [34]. Similar with the age distribution, 58.8% of the farmers have a reported farming experience of at least 30 years. In terms of household income, 63.4% of farmers have family members who are in non-farming jobs and 47.3% have farming income that is less than the income of family members from non-farming jobs. Farmland and paddy land size is at a moderate area of at most 5 hectares for 68.8% and 72.1% of the farmers respectively. Interestingly, farmers appear to be producing more with less land as reflected in the moderate to high paddy yield for 85% of the farmers (at least 7 hyo per tan or 4,200 kg per ha) (Table S1).

Knowledge about climate change and/or its effects may have promoted the high number of Sado Island farmers practicing ECA and have intentions of continuing ECA. Interestingly, while 53% of the farmers strongly agree that climate change has an effect on agriculture, 43.7% have expressed that ECA does not have an impact on climate change, which shows a cognitive dissonance since ECA has been proven to be an effective farming method in mitigating climate change [11]. Only 22.9% of the farmers indicated that ECA can reduce the effects of climate change, and 25.4% perceive ECA as an adaptation for climate change (Table S2).

3.2 Factors influencing ECA continuation among Sado Island farmers

Studies such as by Mathews et al. (2018) have shown that skepticism of the climate change theory is still common within the farming community, although such uncertainties do not appear to affect farmers' attitudes toward the adoption of new farming methods, such as ECA [35]. The 2016 and 2013 surveys of the Sado Island government regarding biodiversity have shown that 61.2% and 66.5% of the respondents respectively have no knowledge of the term biodiversity [33]. In Howden et al. (2007), it is posited that farmers are more likely to believe that climate change is happening if they perceive it as a direct threat to their livelihood [36]. To know the Sado Island farmers' understanding of ECA, ordinal logistic regression was conducted between ECA continuation and specific climate change effects that the farmers can relate to (Table 1). Here, it can be observed that damage to land/farmland has an inverse relationship with farmers' ECA continuation, which means that farmers are three times less likely to continue ECA when they perceive damage to their farmland incurred by climate change. This observed cognitive dissonance among farmers regarding climate change aligns with the observation that farmers tend to focus more on short-term effects – immediate damage to their farm or their products – rather than long-term effects such as temperature increase and season duration changes [37-39].

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This concurs with a case study on a Nepalese community wherein short-term trends in climate change, such as rainfall, affects perception and decision making [40].

Table 1. Relationship of various climate change effects with ECA continuation among farmers in Sado Island, Japan using ordinal logistic regression.

Variable	Estimate	Odds ratio	Significance
Heavy torrential rain	0.445	64.08%	0.230
Increase in temperature	0.588	55.54%	0.231
Typhoons	0.137	87.20%	0.716
Change in distribution of plants/crops	0.139	87.02%	0.762
Change in season duration	0.29	74.83%	0.477
Melting glaciers	1.211	29.79%	0.137
Drought	0.375	68.73%	0.286
Damage to houses	0.079	92.40%	0.926
Damage to land/farmland	-1.206	334.01%	0.009**
Damage of farm products	0.003	99.70%	0.993

Link function: Complementary Log-Log f(x)=log(−log(1−x))
Test of parallel lines – Chi-square: 16.186; df: 11; Sig: 0.134
Goodness of fit – Pearson Chi-square: 202.784; df: 209; Sig:0.608
** significant at $p < 0.01$

The discrepancy between the farmers' knowledge of biodiversity and climate change with their current farming method points to the existence of various other factors that may contribute to their choice to continue ECA. First, exploratory factor analysis was carried out to determine latent factors related to the socio-demographic, ECA-, and GIAHS-related variables (Table 2). Five distinct latent factors were identified, namely: *GIAHS factors*, *farm demographics*, *age effects*, *ECA factors*, and *income effects*. As expected, farmers with a high degree of *GIAHS factors* were more predisposed to have higher *ECA factors* because of their perceived *GIAHS involvement*.

Table 2. Exploratory factor analysis[a] for the variables observed among ECA farmers in Sado Island, Japan.

Factor	Eigenvalue
Factor 1: GIAHS factors	
Level of perceived GIAHS involvement	0.829
Level of perceived youth confidence and pride from GIAHS	0.829
Level of perceived Sado Island agricultural product and branding enhancement	0.789
Level of perceived tourism promotion from GIAHS	0.691
Factor 2: Farm demographics	
Farmland size	0.957
Paddy land size	0.955
Paddy yield	0.215
Factor 3: Age effects	
Age of farmer	0.851
Farming experience	0.858

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Factor 4: ECA factors	
Level of perceived interest in ECA	0.735
Level of perceived opportunities in ECA	0.644
Level of perceived GIAHS involvement	0.231
Level of perceived climate change effects	0.258
Farmer status for receiving ECA subsidy	0.165
Factor 5: Income effects	
Family members have other jobs other than farming	0.793
Farm income is higher than other jobs	0.658

[a]Extraction Method: Principal Component Analysis
Rotation Method: Varimax with Kaiser Normalization

Next, logistic regression was used to determine the relationship of various socio-demographic and ECA/GIAHS factors to ECA continuation (Table 3). Similar to the results in Arslan et al. (2014), *age* and *farming experience* did not show a significant effect on ECA continuation which were labeled as *household-level unobservables [41]*. On the other hand, significant factors influencing ECA continuation among farmers in descending order of odds ratio are as follows: *farmer status for receiving ECA subsidy, level of perceived GIAHS involvement, farmer adaptation to climate change,* and *level of perceived interest in ECA*.

Table 3. Relationship of various socio-demographic and ECA factors with ECA continuation among farmers in Sado Island, Japan.

Variable	Estimate	Odds ratio	Significance
GIAHS factors			
Level of perceived GIAHS involvement	0.659	51.74%	0.022*
Level of perceived youth confidence and pride from GIAHS	-0.293	134.04%	0.364
Level of perceived Sado Island agricultural product and branding enhancement	0.435	64.73%	0.168
Level of perceived tourism promotion from GIAHS	0.347	70.68%	0.225
Age variables			
Age of farmer	-0.227	125.48%	0.338
Farming experience	-0.345	141.20%	0.064
Farm demographics			
Farmland size	0.036	96.46%	0.906
Paddy land size	-0.030	103.05%	0.922
Paddy yield	-0.208	123.12%	0.315
ECA factors			
Level of perceived interest in ECA	0.804	44.75%	0.000**
Level of perceived opportunities in ECA	0.386	67.98%	0.055
Level of perceived climate change effects	0.180	83.53%	0.512
Farmer status for receiving ECA subsidy			
Receiving subsidy up to now	-16.267	1.2E9%	0.000**

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Received before but not currently	-16.417	1.3E9%	0.000**
Never received subsidy	-15.735	-	-
Income variables			
Price satisfaction	0.279	75.65%	0.060
Family members have other jobs other than farming	-0.079	108.22%	0.829
Farm income is higher than other jobs	0.441	64.34%	0.280
Farming adaptation to climate change			
Farmer does any adaptation against climate change	0.766	46.49%	0.046*

Link function: Complementary Log-Log f(x)=log(−log(1−x))
*significant at $p < 0.05$
** significant at $p < 0.01$

Since inclusion to GIAHS is the basis of ECA in Sado Island, the observance of significant effects from the *level of perceived GIAHS involvement* and *level of perceived interest in ECA* towards ECA continuation is expected, which agrees with various studies conducted in different areas globally [41-43]. In addition to GIAHS and ECA factors, *farmer adaptation to climate change* has also been identified to positively drive ECA continuation. This agrees with the findings of another paper which reported that farmers are more likely to undergo adaptation measures than mitigation in terms of addressing climate change [14]. In terms of the farmers' opinions regarding ECA as an adaptation to climate change, they are emphasizing ECA's difference from conventional farming, most especially regarding the use of chemical fertilizers, as shown in the following statements:

> *"Conventional agriculture that depends on chemical fertilizers and pesticides cannot respond to sudden effects of climate change and prevent its impact."*

> *"In order to maximize the adaptive abilities of plants to climate change, it is necessary to use fewer chemicals and go organic. This will enhance the abilities of plants to resist the impacts of climate change."*

> *"Restriction and reduction of the use of chemical fertilizers are important for stabilizing climate change."*

To further understand the trends in ECA adoption among Sado Island farmers, their specified expectations in adopting ECA were tested against ECA continuation. It was shown that farmer expectations of *conservation of biodiversity* and *adding value in the quality of their products* significantly affects their ECA continuation (Table 4). Specifically, those farmers who expect to *conserve biodiversity* and *add value in the quality of their products* are 40% and 47% times more likely to continue ECA than those who did not have these expectations respectively. Indeed, the farmers are highlighting that their farming method creates a good habitat for the Toki birds while consequently increasing the quality and price of their products. This observation is further strengthened when specific reasons to continue ECA were tested against ECA continuation. Results of the analysis revealed that only *improvement of local and global environment* has a significant relationship with ECA continuation such that farmers who chose ECA *to improve local and global environment* are 8% more likely to continue practicing ECA than those who did not choose this reason.

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Table 4. Relationship of farmer preferences with ECA continuation among farmers in Sado Island, Japan.

Variable	Estimate	Odds ratio	Significance
Expectation in adopting ECA			
Carbon sequestration	0.391	67.64%	0.528
Conservation of biodiversity	0.919	39.89%	0.011*
Conservation of water quality	-0.241	127.25%	0.555
Retain underground water	19.67	-	-
Add value in quality of products	0.765	46.53%	0.031*
Decrease effect of weather hazards	0.257	77.34%	0.69
Increase farm related income	-0.027	102.74%	0.946
Promote local industry	1.157	31.44%	0.068
Retain residents in rural area	-0.326	138.54%	0.748
Reason for continuing ECA			
To build trust with consumers	0.017	98.31%	0.726
To improve local and global environment	0.125	88.25%	0.014*
Self-health	-0.032	103.25%	0.643
Good price	0.097	90.76%	0.094
Demand is high	-0.026	102.63%	0.701
To supply better products	0.046	95.50%	0.359
To decrease production cost of fertilizers and pesticides	0.057	94.46%	0.421
Advised by Japan Agricultural Cooperatives or local government	-0.03	103.05%	0.578
Reason for expanding towards ECA			
To build trust with consumers	0.636	52.94%	0.249
To improve local and global environment	0.781	45.79%	0.180
Self-health	0.46	63.13%	0.657
Good price	0.64	52.73%	0.400
Demand is high	-0.337	140.07%	0.554
To supply better products	-0.424	152.81%	0.458
To decrease use of fertilizers and pesticide	0.629	53.31%	0.416
Advised by Japan Agricultural Cooperatives or local government	-1.278	358.95%	0.006**
Farmers' wish for farming			
Will expand area, same farming method	2.511	8.12%	0.001**
Will expand current farming to ECA	21.457	0.00%	-
Area no change, same farming method	1.913	14.76%	0.000**
Area no change, towards ECA	2.649	7.07%	0.002**
Decrease area, same farming method	1.238	29.00%	0.046*

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Decrease area, towards ordinary farming	-0.984	267.51%	0.443
Others	-	-	.

Link function: Complementary Log-Log f(x)=log(−log(1−x))
*significant at $p < 0.05$
** significant at $p < 0.01$

In terms of reasons to expand towards ECA, only *advised by Japan Agricultural Cooperatives or local government* was found to have a significant negative effect on ECA continuation. This agrees with previous studies which regard farmers as active individuals that enforce internal farm decisions [44,45]. This is further supported by the significant positive effects of various farm management implementations that the farmers wish to implement in their farms (i.e., decrease or increase land area, and shift towards ECA) which may allow them to improve yield and farm produce value. Using correspondence analysis and chi-square test, it was further found that region and paddy yield were related such that the Central West area is associated with high paddy yield, while southern regions are associated with low yields, respectively (Figure 2). Interestingly, while a greater proportion of the farmers (83.9%) reported having paddy yields of 7-9 hyo (420-540 kg), most of these are coming from small to intermediate paddy land sizes of at most 5 hectares (72.1% of the farmers). This observation aligns with the data on average cultivated land per farm household at 1.6 ha in Japan, which is in stark contrast with the higher values reported for other countries such as USA (176.1 ha), UK (70.1 ha), Germany (30.3 ha) and France (38.5 ha) [46]. Indeed, an inverse relationship between paddy area and yield has been shown to exist in various countries such as China, Africa, Turkey, and even Japan in recent years, which was attributed to differences in labor intensity and level of commercialization [47-50].

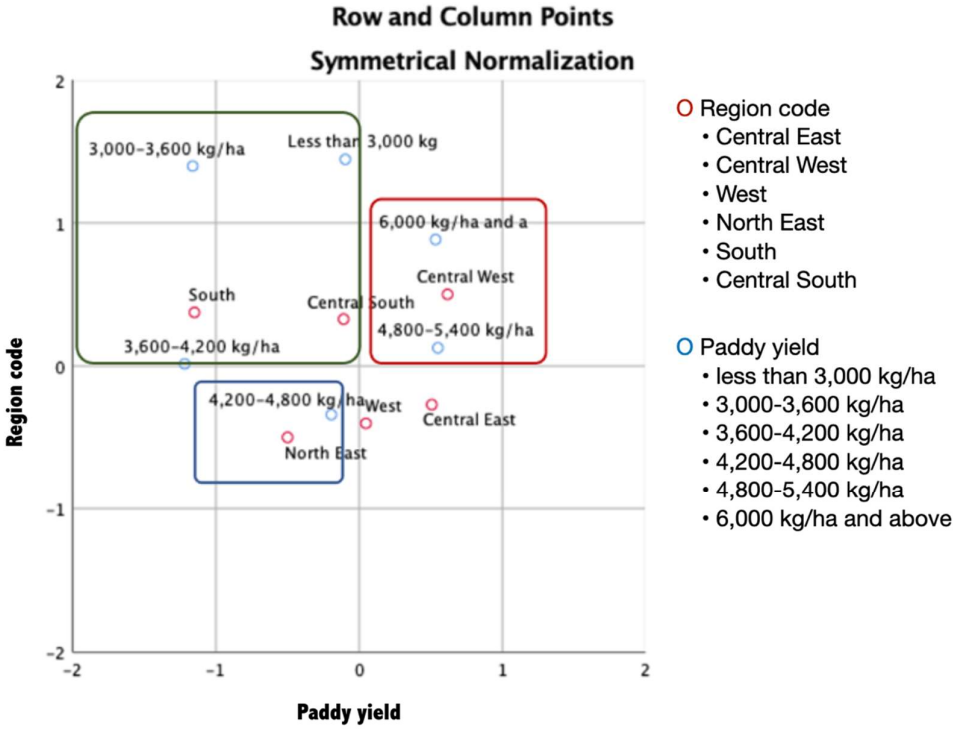

Figure 2. Biplot of region and paddy yield

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4. Discussion

While a lot of research has been conducted regarding farmers' perceptions of climate change and the adoption of environmentally friendly methods, only a few papers in Japan are focusing on what factors contribute to the ECA continuation of farmers. Analyzing this is vital to reducing GHGs produced in Japan's agricultural sector and further promoting the adoption of ECA in various prefectures.

ECA is an agricultural method that generally aims to conserve the environment and mitigate climate change; however, this concept may not yet be fully understood by farmers since ECA is still in its early stage in Japan [51]. In this study, farmers' understanding of ECA as a climate change mitigation method was determined by testing the relationship between climate change effects farmers can relate to and their ECA continuation. The main expectation for this is similar to that of Howden et al. (2007) which shows that when negative effects are caused by climate change, farmers believe that climate change is actually happening and would therefore adopt climate change mitigation methods [36]. However, the findings of the study were contradictory to the inference of Howden et al. (2007), since Sado Island farmers who relate climate change with damage to farmland are three times less likely to continue ECA. This cognitive dissonance may be partly due to the farmers' lack of understanding of the actual climate change mitigating effects of ECA. To further contextualize the inference of Howden et al. (2007) in this study, it can be inferred that Sado Island farmers are more likely to believe that climate change is happening and take adaptive measures if they perceive it as a direct threat and they understand the mechanisms of current technologies developed to mitigate climate change (i.e., ECA). The data from this study strongly align with the findings of another paper which also focused on knowing the ECA interest of farmers in Fujioka, Japan. The Japanese farmers exhibited very high biodiversity conservation awareness and identified the improvement of their local and global environment as their main reason to continue ECA, however, their ECA interest is low [52]. This proves that the concept of ECA is not yet fully understood or disseminated among rural communities, as also shown in the findings of this paper.

The Sado Island farmers have two conflicting beliefs since they are less likely to continue ECA adoption when they perceive damages to their farmland caused by climate change. These beliefs are contradictory since ECA is a proven climate change mitigator, so the expected relationship between climate change perception and ECA adoption should be direct and not inverse. In the cognitive dissonance theory of Leon Festinger, there are three suggestions on how to reduce the inconsistency between two different beliefs, as well as contrasting actions and attitudes [53]. First, selective exposure to information can be done. In the case of Sado Island farmers, effective information dissemination regarding ECA can be done through various channels, most especially through farmers' main sources of information. By distributing easy-to-understand information regarding ECA and how it can mitigate climate change, cognitive dissonance can be reduced. Another method is to reduce the farmers' post-decision dissonance by generating avenues for reassurance regarding the new knowledge they were exposed to. Post-decision dissonance refers to doubts being experienced by people after making an important decision or a switch in a belief that may be difficult to reverse. In the case of Sado Island farmers, a sudden change in their ECA understanding may cause post-decision dissonance since it's different from what they currently believe in. By conducting workshops among farmer leaders whom farmers highly respect and highly trust, they can reassure their co-farmers that their ECA understanding is correct, and post-decision

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dissonance can therefore be reduced. Lastly, Festinger also suggested the minimal justification hypothesis, wherein attitudinal change can be done by targeting behavioral change first and offering just enough incentive to elicit overt compliance. The case of Sado Island farmers is unique since the results of regressions have shown that receiving a subsidy induces a negative effect on their ECA continuation. Furthermore, being advised by JA lessens their likelihood to expand toward ECA. This shows that instead of financial incentives, other types of rewards for Sado Island farmers can be explored, which can be related to the top factors that influence their ECA continuation, (i.e., improvement of their local or global environment, biodiversity conservation, and adding value to the quality of their agricultural products). All these strategies may reduce the farmers' existing cognitive dissonance and further encourage ECA continuation. In a study that conducted participatory experiments among Filipino rice farmers who had conflicting beliefs and misperceptions of pests and pesticides, it was found that dissonance resolution was proven to be effective [54]. Furthermore, labor reduction and money savings induced positive changes in the farmers' perceptions, attitudes, and practices. To improve the diffusion of farmer-to-farmer experiences, the authors recommended the use of media, such as newspapers, radio, and television. This approach may also be applied in resolving the cognitive dissonance among Sado Island farmers.

The effect of subsidies and other government-issued financial aid on the uptake of conservation agriculture has been analyzed by different groups. In Sardinia, Italy such financial instruments were able to encourage the adoption of conservation agriculture [55]. This is similar to reports from farmers in Ohio, USA where a weak positive relationship between participation in state-funded assistance and conservation agriculture was observed [56]. On the other hand, a more recent study conducted in Scotland reported that compensation alone does not ensure the continued adoption of conservation agriculture, citing that lack of knowledge and perception of such activities tends to hinder farmer participation [57]. In addition, the cost of subsidy compliance, as well as administrative and transaction costs have been found to deter farmer participation [58,59]. In this study, key informant interviews were conducted to gain critical insights on the role of subsidy on ECA continuation. Here, a respondent said that *"…since Good Agricultural Practice (GAP) became a condition for getting the subsidy of direct payments of ECA, the paper works have increased and became more complicated. So, I stopped applying for this subsidy."* Another respondent confirmed this and said that he is not receiving any ECA subsidy and added that there are more farmers like him. This also aligns with the findings of another paper focusing on Fujioka farmers who had the same sentiments regarding subsidies, such as the complex administrative process in applying and increased paperwork [52].

In the 2003 report of the Organization for Economic Cooperation and Development on environmentally harmful subsidies, it was highlighted that subsidies which scale with production are more likely to be environmentally harmful when compared with direct payments which are decoupled from farm output [60]. Thus, such distribution methods may have played a role in the negative effects of ECA subsidy on ECA continuation. Currently, eligibility requirements of ECA subsidy for farmers are as follows: 1) commercial farms having at least 0.30 ha of farm area under cultivation and farm products sold at more than JPY 500,000 per annum, 2) complying with international standard GAP and practicing at least one of the 11 production activities promoted by MAFF, 3) jointly applying in a group, and 4) approved by local governments that contribute to the conservation of the natural environment. Meanwhile, the requirements for being a council member of the *Toki-to-kurasu-satojukuri suishin kyogikai are* to be a commercial farmer and

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practice ECA living with *Toki*. In a study on newcomer organic farmers in Japan, it was found that subsidies were perceived as a double-edged sword and that subsidies push farmers towards a productivist pathway, wherein they are being driven to focus on economic benefits rather than environmental and social aspects [61]. From another perspective of subsidy, various studies have associated conservation agriculture as being a risky investment due to difficulties in accessing insurance, the need for farmers to learn new farming techniques, and return of investment that may reach up to four years or more [62,63]. In addition, it was also shown that in some countries, financial support policies have proven to be insufficient in driving ECA implementation [32,64,65]. Hence, other forms of incentives should be explored aside from subsidies to encourage ECA adoption and continuation in Japan, as discussed earlier.

When asked about their opinion on ECA's sustainability, the farmers had mixed opinions, most especially regarding the environmental and economic sustainability of this farming method. On the positive side, some think that ECA has the potential to decrease the use of pesticides and thus contribute to climate change adaptation. They also think that ECA can be sustainable if there will be better community participation and joint efforts between consumers and producers. On the negative side, the farmers are emphasizing that while ECA's adoption is possible, it doesn't currently present economic merits. For example, in organic farming, some farmers are saying that the repercussions of using fewer or no chemical fertilizers are the increase in farming expenses and labor. These sentiments agree with the findings of other studies which reported that while giving priority to environment-friendly agriculture may be beneficial in the long run, its sustainability may be difficult to attain when farmers are resource-constrained and experience income reduction due to less agricultural productivity [66,67]. However, in the case of Sado Island farmers, this should be further analyzed since receiving subsidies may negatively impact their ECA continuation, as discussed earlier. A study focusing on this aspect is therefore recommended for future researchers on this topic.

In summary, 14 factors were identified that affect ECA continuation among Sado Island farmers. These can be seen in the heat map that shows the positive and negative relationships of the variables with ECA continuation (Figure 3). It can be inferred that farmers see their roles more from a macro perspective, specifically the role they are playing to improve their local and global environment. Factors that were found to have a positive significant relationship with ECA continuation that support this are: 1) level of perceived GIAHS involvement; 2) level of perceived interest in ECA; 3) reasons to continue ECA, particularly to improve the local and global environment; 4) farmer expectations from ECA, particularly biodiversity conservation and to add value to product quality; and 5) farmer doing adaptation measures for climate change. It is also important to highlight that farmer perception appears to take precedence over aligning with cooperative groups or the government in terms of farm-related decision-making [19].

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Figure 3. Relationship of identified factors affecting ECA continuation. Connecting lines in red indicates positive intensity of relationship with ECA continuation, while green indicates negative intensity of relationship.

5. Conclusions and Recommendations

Japan's initiatives to promote sustainable farming began in the early 1990s, with various prefectures implementing ecologically friendly farming practices in the early 2000s, such as Niigata and Ishikawa which are both GIAHS sites. This study focused on analyzing the factors influencing the continuation of environmental conservation agriculture (ECA) among Sado Island farmers. Similar to the survey results of the Sado Island government, our findings suggest the presence of conflicting attitudes, beliefs, and behaviors between the farmers' prevalent farming methodology (i.e., ECA) and their perceived impact of ECA to mitigate climate change. This, therefore, highlights the need to shift the highlight of information dissemination activities from the concept of ECA to how ECA can improve biodiversity and help address climate change issues. Effective strategies could also be done to address the existing cognitive dissonance, such as by selective exposure to easy-to-understand ECA information, addressing post-decision dissonance by training farmer leaders, and implementing the minimal justification approach posited by Leon Festinger [53] using other forms of incentives aside from subsidies.

Analysis of the effects of each variable on ECA continuation further revealed the enhancing effect of the farmers' perceived level of involvement towards Globally Important Agricultural Heritage Systems (GIAHS) on their continuation of ECA as confirmed by both the exploratory factor analysis and ordinal regressions. For the continued success of GIAHS and ECA in Sado Island, local concerted efforts must be put in place to assure that farmers feel directly involved in GIAHS activities. Therefore, strategies to permeate not only the concept of GIAHS but its integration towards youth involvement, Sado Island tourism management, and branding should be strengthened, which can also contribute to a higher generation of revenues.

Critical farmer and farm dynamics that were observed in Sado Island involve the enhancing effects of the various farm management optimizations that farmers would wish to do, as well as the reducing effects of ECA subsidy on ECA continuation. Such micro effects are put side by side with farmers' macro perspectives involving the role they are playing in climate change mitigation. However, this promising future for ECA in Sado Island may be hampered by the aging age structure and declining population of the island. Therefore, it is imperative to echo the testimonials of the farmers seeking enhanced youth activation and participation in the field of agriculture, such as by integrating other activities like processing and marketing of agricultural produce, and the introduction of the concept of sixth industry. There is also a need for the continuous promotion of ECA-related policies, not only on Sado Island but in other GIAHS sites in Japan as well.

Supplementary Materials: Table S1: Socio-demographic characteristics of the sampled farmers in Sado Island, Japan; Table S2: ECA-related and climate change-related factors of farmers in Sado Island, Japan.

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Data Availability Statement: Questionnaire survey data can be available form the first author upon request.

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