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Drivers of Environmental Conservation Agriculture in Sado Island, Niigata Prefecture, Japan

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Abstract: Sado Island in the Niigata prefecture in 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 aimed to identify drivers of ECA among Sado Island paddy farmers. The data revealed the prevalence of farmers' cognitive dissonance between ECA and its mitigating effects on climate change. Our findings confirmed the importance of perceived GIAHS involvement in the continuation of ECA. In addition, other identified drivers of ECA 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 paddy 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 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

Citation: Maharjan, K.L.; Gonzalvo, C.M.; Aala, W.J.F. Drivers of Environmental Conservation Agriculture in Sado Island, Niigata Prefecture, Japan. *Sustainability* **2022**, *14*, 9881. https://doi.org/10.3390/su14169881

Academic Editor: Luca Salvati

Received: 7 June 2022
Accepted: 7 August 2022
Published: 10 August 2022

1. Introduction

Climate change is a global phenomenon, and its irreversible effects on the agricultural sector and food security are evident today. In previous centuries, the repercussions of the industrial revolution and modernization have led to the rapid increase in greenhouse gas (GHG) concentration. Since agriculture is strongly dependent on weather patterns, climate change will significantly impact it [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, reaching the 10 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, Japan's total greenhouse gas emissions (GHGs) amounted to 1212 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 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 emphasizes carbon recycling and the next-generation solar cells [7]. These global and national scenarios emphasize the need to develop viable solutions to mitigate the continuing effects of climate change, especially in the agricultural sector.

In the field of agriculture, one of Japan's main strategies to reduce its total emissions 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 providing 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, such as those set by local governments or in accordance with consumer agreements, among others), which means that the government can support more farmers. The promotion of ECA is important since almost 140,000 tons of GHGs are being reduced annually through activities supported by ECA direct payments [11]. Furthermore, ECA diffusion can also improve the efficiency of farming in Japan and the structure of agriculture [12]. Despite the proven benefits of ECA in mitigating climate change, a decrease in ECA utilization has been observed in 31 out of 47 prefectures (65.9%) from 2016 to 2020 [13] (Figure 1). ECA drivers should thus be identified and analyzed to ensure ECA's sustainability in Japan. This paper aims to contribute to this endeavor, specifically by identifying ECA drivers in Sado Island, Niigata prefecture–a globally important agricultural heritage system (GIAHS) situated in a prefecture with relatively higher ECA adoption than other prefectures (10th in Japan in 2016) [13].

1.1. Farmer Perceptions of Climate Change and Adoption of Environmentally Friendly Farming Methods

Numerous studies have explored farmers' knowledge, attitudes, and perceptions of climate change and its associated risks [14–18]. Many papers reported that farmers are aware of climate change; however, very few papers focused on analyzing how farmers view the role of environmentally friendly farming methods in mitigating climate change. Furthermore, farmers' views on climate change vary widely, and this heterogeneity influences their individual, community, and national decisions. 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 [19]. Furthermore, the willingness of Japanese farmers to participate in climate change adaptation measures is strongly determined by their preferences [20]. 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 as Globally Important Agricultural Heritage Systems (GIAHS) [21]. 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 producing sustainably produced goods and services [22]. The FAO has designated 62 systems in 22 countries since 2005 and is currently reviewing 15 new proposals from eight 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 [21]. This paper particularly focused on Sado Island in Niigata prefecture, one of the first GIAHS sites designated in a developed country. The incorporation of ECA in GIAHS sites and various agri-environmental schemes has been documented in Japan, and a decline can be observed in 31 out of 47 prefectures [13]. For example, Shiga prefecture, which plays a big role in reducing the pollution in Lake Biwa by implementing ECA and agri-environmental policies, experienced a decline in the percentage of ECA utilization from 32.8% in 2016 to 25.3% in 2020. This declining trend in terms of ECA uptake stresses the need to identify factors that can retain or increase ECA adopters in Japan.

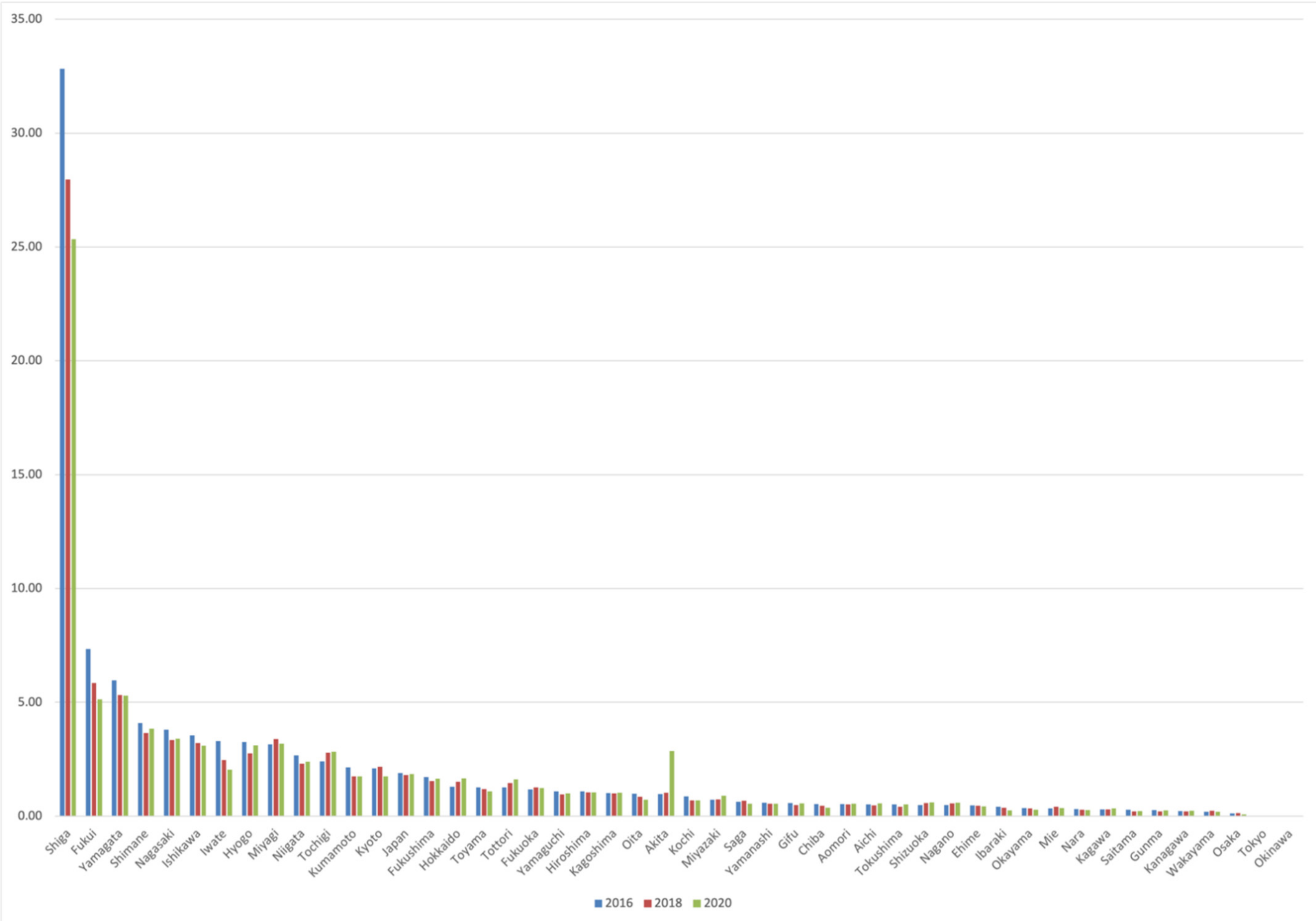

Figure 1. Percentage of ECA utilization in Japan. Source: Maharjan et al. (2022), with permission [13].

As discussed above, the application of ECA for mitigating climate change and promoting sustainable agriculture is 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 of paddy farmers and their possible implications. Moreover, this study focused on Sado Island in Niigata prefecture, a GIAHS, thereby producing recommendations on how ECA may impact other GIAHS sites and ECA farmers.

1.2. Theoretical Foundations and Research Hypothesis

This paper is based on several theoretical underpinnings. First is the diffusion of innovations theory, which can support how the ECA farming method has diffused among Sado Island farmers. Rogers (2003) defined diffusion as a process by which an innovation is communicated through certain channels over time among members of a social system [23]. Based on the discussion above, it can be observed that even at its development stage, ECA uptake is slowly declining in Japan. Inside the diffusion process, different factors determine a technology's success or failure and the behavior of its adopters. Two of the most famous theories that explain this are social learning theory (SLT) and social cognitive theory (SCT) by Albert Bandura [24,25]. These theories provide an explanation of how people imitate behaviors of role models, how positive reinforcement can lead to a continuance of behavior, and how cognitive processes are driven by social consequences that occur in a person's environment. SLT and SCT can support how various factors positively or negatively affect the ECA continuation of Sado Island farmers. Lastly, the social movement theory explains how collective behavior can induce social change. This is commonly used in papers that aim to understand the impacts of people's actions on addressing climate change [26,27]. In the context of this paper, this theory can explain how the collective action of ECA farmers can increase ECA uptake on Sado Island. These theories comprise the theoretical foundations of this study, which mainly aim to identify drivers of ECA. In this paper, we hypothesized that various factors affect the ECA continuation of Sado island farmers, namely: (1) climate change effects; (2) socio-demographic factors; (3) ECA/GIAHS factors; and (4) farmer preferences. These factors will be listed in detail and tested in the subsequent sections.

2. Methodology

2.1. Data Collection

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. All the council members are ECA farmers; thus, questionnaires were sent to these farmers to gather their responses. 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 would 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 the 415 council members, which essentially represent the target farmers of the study on 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) opinions 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], which were nationwide surveys regarding awareness of the impacts of global warming on agriculture, forestry and fisheries; adaptation measures, awareness of environmentally friendly agriculture (including organic farming and their produce); and awareness of the introduction of technologies contributing to environmentally friendly agriculture in Japan. The authors translated all the responses that are in local Japanese into English.

2.2. Data Analysis

To identify the significant drivers of ECA among Sado Island farmers, ordinal logistic regression was employed, and the resulting model was verified using model fit, goodness-of-fit, and test of parallel lines in SPSS v.27 (IBM, NY, USA). Qualitative data obtained in the survey were used to support the discussion of the findings.

In this study, the ECA farmers were asked whether they were planning to continue their ECA adoption or not using a three-point rating scale (i.e., 1 = yes, 2 = neutral, and 3 = no). This served as the dependent variable for all the regression analyses. We first sought to determine the effect of farmers' perception of climate change effects on their ECA continuation, followed by the effects of socio-demographic factors, ECA/GIAHS factors, and farmer preferences. Lastly, we created a summative heat map showing all the identified ECA drivers based on the results of the ordinal logistic regressions.

3. Environmental Conservation Agriculture on Sado Island

3.1. Description of Sado Island

The study was conducted on Sado Island, located west of the Niigata prefecture shoreline. It is the sixth-largest island in Japan, with a complex ecosystem and 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 2). Sado Island is around 855 km^2 with a total of 7941.88 ha of cultivated land, of which 6128.41 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 7103 in 2010 to 5927 in 2015, wherein 1614 are those who produce food for self-consumption only [31]. This trend has been observed in a previous study, in 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 [32]. 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" [33]. 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. Another study concurs 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 [34]. Farmers grow other agricultural crops like apples, oranges, pears, persimmons, cherries, strawberries, watermelons, and 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 significant factor in its designation as a GIAHS.

3.2. ECA's Diffusion in Sado Island

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 highly 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.

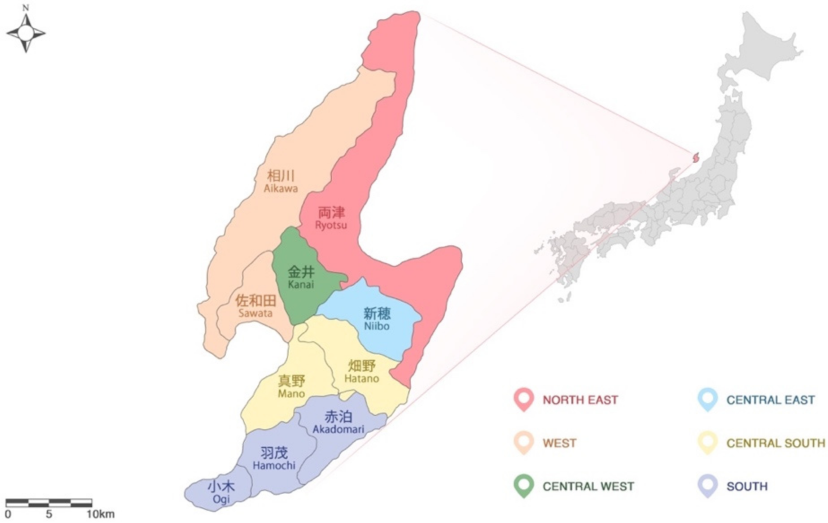

Figure 2. Map of Sado Island showing areas included in the study.

Sado Island was also able to obtain a rice certification with *Tokimai* branding in 2008, which enabled farmers to gain a reasonable profit for their harvest. Interestingly, rice produced in fields that provide habitat to birds has the highest price among rice brands produced in coexistence with living creatures [35]. 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 were concerned with safer cultivation methods and paddy field biodiversity [36]. Moreover, it was observed that consumers were willing to pay for the *Tokimai* rice brand to support the conservation efforts on Sado Island. The report also concluded that the taste of rice should be emphasized to further boost its marketing.

3.3. Socio-Demographic and Farm-Related Data of ECA Farmers on Sado Island

Based on Japan's 2015 Agriculture and Forestry census, Sado Island has a total of 5927 farmers, specifically comprising 4313 commercial farmers and 1614 farmers who produce food for self-consumption only [31]. There are 4248 farm management entities, including farmers and companies holding 7042 ha of land. Of them, 4204 are using 6128 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 which uses 50-80% fewer chemicals and pesticides than the conventional farming practice on the island, 10.8% practice organic farming, 9.3% conduct eco-farming or other ECA-related methods, and 2.5% employ ECA-oriented farming (Table 1). 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 2). 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%).

Table 1. Socio-demographic characteristics of the ECA farmers in Sado Island, Japan.

Variable	Frequency (n = 279)	Percentage (%)
Region		
Central East	59	21.1
Central West	57	20.4
West	45	16.1
North East	42	15.1
South	38	13.6
Central South	38	13.6
TOTAL:	279	100.0
Age		
15–39	5	1.8
40–49	10	3.6
50–59	40	14.3
60–64	53	19.0
65–79	143	51.3
80 and above	28	10.0
TOTAL:	279	100.0
Sex		
Male	260	93.2
Female	19	6.8
TOTAL:	279	100.0
Farming experience		
9 years and below	17	6.1
10–19	62	22.2
20–29	36	12.9
30–39	51	18.3
40 years and above	113	40.5
TOTAL:	279	100.0
Commercial farmer [1]		
Yes	267	95.7
No	12	4.3
TOTAL:	279	100.0
Family members have non-farming jobs		
Yes	177	63.4
No	102	36.6
TOTAL:	279	100.0
Farm income is higher than income from other jobs		
Yes	53	19.0
No	132	47.3
No answer	94	33.7
TOTAL:	279	100.0
Family farm registration type		
Family farm not registered as a company	257	92.1
Family farm registered as a company	7	2.5
Organized farm	7	2.5
Others	8	2.9
TOTAL:	279	100.0
Farming method [2]		
Special farming	216	77.4
Organic farming	30	10.8
Eco-farming or related	26	9.3
ECA-oriented farming	7	2.5
TOTAL:	279	100.0

Table 1. *Cont.*

Variable	Frequency (n = 279)	Percentage (%)
Farmland size		
Less than 1 ha	48	17.2
1–5 ha	144	51.6
5–10 ha	33	11.8
10–20 ha	28	10.0
20–30 ha	13	4.7
30–50 ha	7	2.5
50 ha and above	6	2.2
TOTAL:	279	100.0
Paddy land area/size		
Less than 1 ha	56	20.1
1–5 ha	145	52.0
5–10 ha	28	10.0
10–20 ha	29	10.4
20–30 ha	8	2.9
30–50 ha	7	2.5
50 ha and above	6	2.2
TOTAL:	279	100.0
Paddy yield (per tan) [3]		
Less than 5 hyo	4	1.4
5–6 hyo	10	3.6
6–7 hyo	28	10.0
7–8 hyo	113	40.5
8–9 hyo	121	43.4
10 hyo and above	3	1.1
TOTAL:	279	100.0

[1] A commercial farmer is required to have a farm area of at least 0.30 ha and sells farm products valued at more than JPY 500,000 per annum. This is also one of the criteria for becoming a council member for the promotion of the *Toki-to-kurasu-satojukuri-suishin kyogikai* (Council for Promotion of community development living with *Toki*). [2] Special farming (low-input farming): uses 50–80% fewer fertilizers and pesticides than the conventional farming practice of the locality, complies with GIAHS regulations; Organic farming: certified as organic by Japanese Agricultural Standards (JAS), or no JAS certification but does not use chemical fertilizers and synthetic pesticides; Eco-farming: low-input and environmentally friendly farming methods based on the standards set by the local government or in accordance with consumer agreements, among others; ECA-oriented farming: uses chemical fertilizers and pesticides prescribed and practiced in the ECA-farming region. [3] 1 hyo = 60 kg, 1 tan = 10a = 1000 sqm

On the other hand, water management (65.6%), soil management (40.5%), change in planting time (38.7%), and ameliorating pest/disease (21.5%) are among the top adaptations that the farmers were practicing 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 implemented in other countries [37,38]. The perceived levels of GIAHS involvement and the enhancement of agricultural products/brand in Sado Island and their 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) [39].

Table 2. ECA-related and climate change-related factors of farmers in Sado Island, Japan.

Variable	Frequency (n = 279)	Percentage (%)
ECA interest [O]		
High	233	83.5
Not high	26	9.3
Neutral	20	7.2
TOTAL:	279	100.0
Status for receiving ECA subsidy		
Receiving subsidy up to now	156	55.9
Receiving before but not currently	38	13.6
Never received subsidy	56	20.1
Others	5	1.8
No answer	24	8.6
TOTAL:	279	100.0
ECA continuation [O]		
Yes	242	86.7
No	5	1.8
Neutral	32	11.5
TOTAL:	279	100.0
Reason for ECA continuation *		
To build trust with consumers	135	55.8
To improve local and global environment	114	47.1
To supply better products	109	45.0
Advised by Japan Agricultural Cooperatives or local government	88	36.4
Good price	68	28.1
Demand is high	48	19.8
Self-health	42	17.4
To decrease production cost of fertilizers and pesticides	39	16.1
Others	8	3.3
Relation of ECA with climate change *		
No impact on climate change	122	43.7
ECA is related with climate change as an adaptation	71	25.4
Reducing the effect	64	22.9
Others	9	3.2
Opinion on whether climate change influences agriculture or not [O]		
Strongly yes	148	53.0
Yes	126	45.2
No	3	1.1
Strongly no	1	0.4
Neutral	1	0.4
TOTAL:	279	100.0
Expectation in adopting ECA *		
Conservation of biodiversity	205	73.5
Add value to quality of products	186	66.7
Conservation of water (quality)	94	33.7
Increase farm related income	94	33.7
Promote local industry	59	21.1
Carbon sequestration	45	16.1
Decrease effect of weather hazards	36	12.9
Retain underground water	15	5.4
Retain residents in rural area	12	4.3
Others	8	2.9

Table 2. *Cont.*

Variable	Frequency (*n* = 279)	Percentage (%)
Reason for strengthening ECA adoption *		
To build trust with consumers	71	25.4
To improve local and global environment	61	21.9
To supply better products	50	17.9
Good price	31	11.1
Demand is high	30	10.8
To decrease use of fertilizers and pesticides	25	9.0
Advised by Japan Agricultural Cooperatives or local government	22	7.9
Self-health	16	5.7
Others	4	1.4
Effects of climate change *		
Temperature (i.e., rise of sea temperature, extreme hot days)	253	90.7
Heavy (torrential) guerilla rain, flood	174	62.4
Drought	149	53.4
Typhoon, cyclone, tornado	134	48.0
Damage to farm products	122	43.7
Change in season/duration	92	33.0
Change in distribution of plants/crops	64	22.9
Damage to land/farmland	53	19.0
Melting of glaciers, sea-level rise	50	17.9
Damage to houses/buildings	23	8.2
Others	7	2.5
Farming adaptation to climate change *		
Water management	183	65.6
Soil management	113	40.5
Change in planting time	108	38.7
Ameliorate pest/diseases	60	21.5
High-temperature tolerant variety	24	8.6
Change land use pattern	13	4.7
Choose different crop	5	1.8
Others	11	3.9
GIAHS involvement [O]		
Strongly yes	122	43.7
Strongly no	28	10.0
Not sure	129	46.2
TOTAL:	279	100.0
Opinion on GIAHS giving pride and confidence to youths [O]		
Strongly yes	108	38.7
Strongly no	33	11.8
Not sure	138	49.5
TOTAL:	279	100.0
Opinion on GIAHS enhancing agricultural products/brand of Sado Island [O]		
Strongly yes	165	59.1
Strongly no	24	8.6
Not sure	90	32.3
TOTAL:	279	100.0

Table 2. *Cont.*

Variable	Frequency (n = 279)	Percentage (%)
Opinion on GIAHS promoting tourism in Sado Island ^{O}		
Strongly yes	139	49.8
Strongly no	42	15.1
Not sure	98	35.1
TOTAL:	279	100.0
Farmers' wish for farming *		
Retain area size, retain farming method	160	57.3
Will expand area, retain farming method	42	15.1
Retain area size, but towards strengthening ECA adoption	32	11.5
Decrease area size, retain farming method	26	9.3
Will expand area, towards strengthening ECA adoption	10	3.6
Decrease area size, towards ordinary farming	1	0.4
Others	8	2.9

* Multiple responses. ^{O} ordinal level variable. Questions related to ECA, and climate change were adopted from MAFF (2015, 2016, and 2018).

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-dominated, as reported in other studies [40]. Similar to 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 produce more with less land, as reflected in the moderate to high paddy yield for 85% of the farmers (at least seven hyo per tan or 4200 kg per ha) (Table 1).

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% expressed that ECA does not have an impact on climate change, thus indicating 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 to climate change (Table 2).

4. Results

Drivers of Environmental Conservation Agriculture on Sado Island

Among the climate change effects included in this study, only damage to land/farmland had a significant effect on ECA continuation (Table 3). It is a negative driver of ECA, which means the farmers are three times less likely to continue ECA when they perceive damage to their farmland incurred by climate change.

Among all the socio-demographic, ECA, and GIAHS variables, the identified drivers of ECA in descending order of odds ratio are farmer status for receiving ECA subsidy, level of perceived GIAHS involvement, farmer adaptation to climate change, and level of perceived interest in ECA (Table 4). 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].

In terms of farmer preferences, the identified ECA drivers are biodiversity conservation and adding value to the quality of their products (Table 5). Specifically, those farmers who expect to conserve biodiversity and add value to 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. The results of the analysis revealed that only improvement of the 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.

Table 3. Relationship of various climate change effects with ECA continuation among farmers in Sado Island, Japan, using ordinal logistic regression.

Variable	Estimate	Odds Ratio	Significance
Effects of climate change			
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 to 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 $p < 0.01$

Table 4. 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

Table 4. *Cont.*

Variable	Estimate	Odds Ratio	Significance
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 **
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 doing farming adaptation measures 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 $p < 0.01$

Table 5. 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 to 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

Table 5. *Cont.*

Variable	Estimate	Odds Ratio	Significance
Reason for strengthening ECA adoption			
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, retain farming method	2.511	8.12%	0.001 **
Will expand area, towards strengthening ECA adoption	21.457	0.00%	-
Retain area size, retain farming method	1.913	14.76%	0.000 **
Retain area size, but towards strengthening ECA adoption	2.649	7.07%	0.002 **
Decrease area, retain farming method	1.238	29.00%	0.046 *
Decrease area, towards ordinary farming	−0.984	267.51%	0.443

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 strengthen ECA adoption, only the variable "advised by Japan Agricultural Cooperatives or local government" was found to significantly affect ECA continuation. This agrees with previous studies that regard farmers as active individuals that enforce internal farm decisions [42,43]. 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 3). 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 the USA (176.1 ha), UK (70.1 ha), Germany (30.3 ha) and France (38.5 ha) [44]. 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 [45–48].

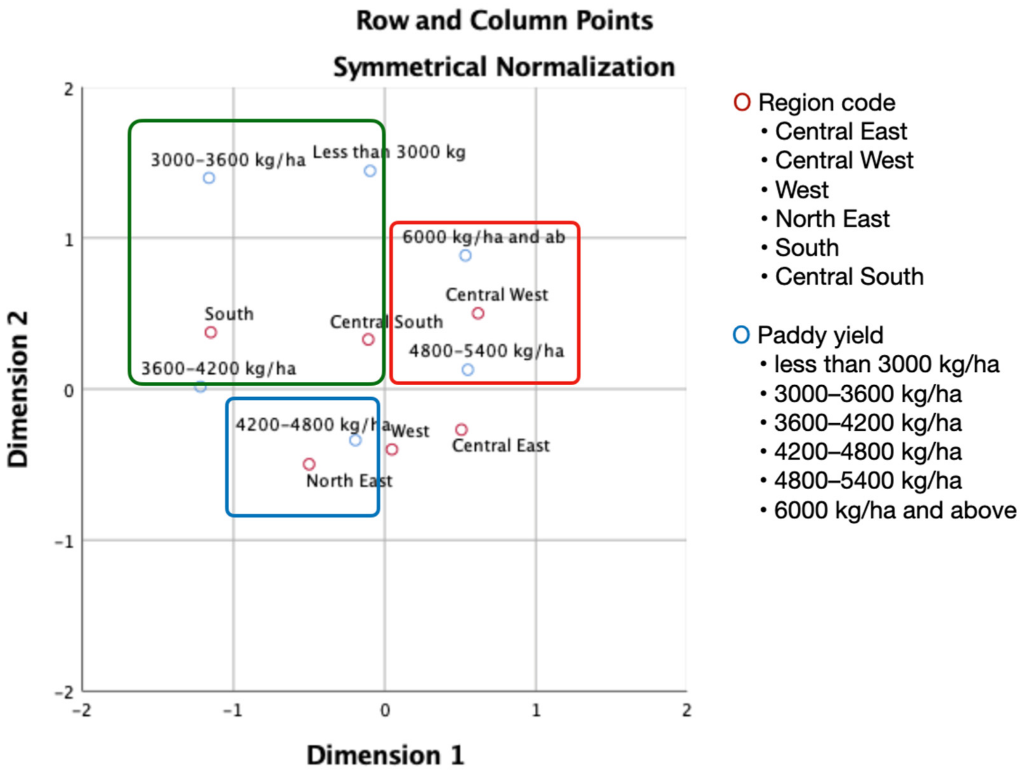

Figure 3. Biplot of region and paddy yield.

5. 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. This paper addressed this by identifying factors that can contribute to the ECA continuation of Sado Island farmers. Figure 4 shows the factors identified with a significant relationship with ECA continuation. Estimates were transformed into a color value based on a two-color gradient, with green representing the increasing magnitude of negative relationship and red representing the increasing magnitude of a positive relationship.

5.1. Cognitive Dissonance between ECA Understanding and Its Capability to Mitigate Climate Change

ECA is an agricultural method that generally aims to conserve the environment and mitigate climate change; however, farmers may not yet fully understand this concept since ECA is still in its early stage in Japan [49]. Previous studies have shown that skepticism of the climate change theory is still common within the farming community. However, such uncertainties do not appear to affect farmers' attitudes toward the adoption of new farming methods, such as ECA [50]. The 2016 and 2013 surveys of the Sado Island government regarding biodiversity have shown that 61.2% and 66.5% of the respondents have no knowledge of the term biodiversity [39]. 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 [51]. Our data revealed that farmers are less likely to continue ECA when they perceive damage to their farmlands caused by climate change. This finding aligns with other papers which reported 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 [52–54]. This concurs with a case study on a Nepalese community that reported how short-term trends in climate change, such as rainfall, affect perception and decision-making [55]. This study's findings 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.

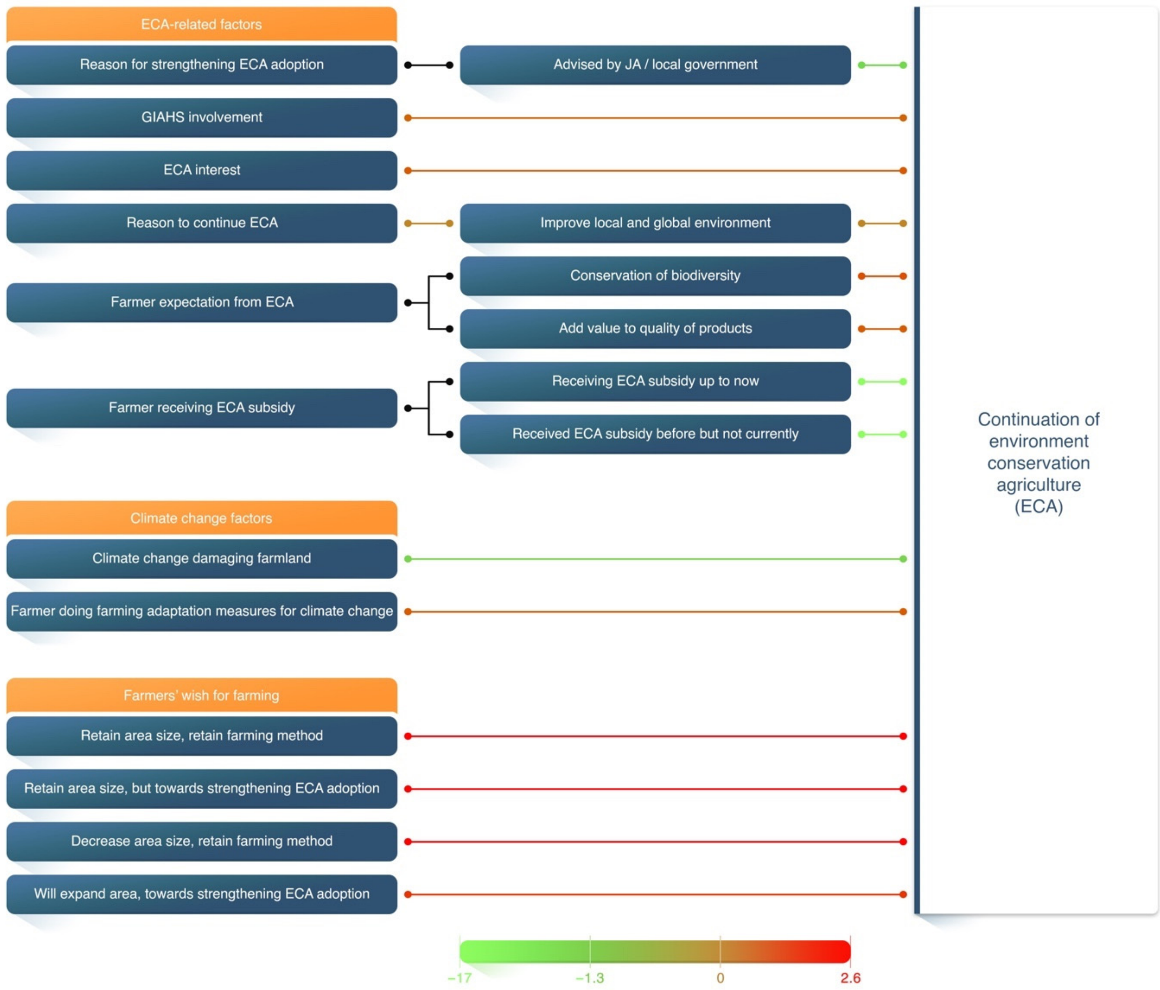

Figure 4. Relationship of identified factors affecting ECA continuation. The connecting lines in red indicate the positive intensity of the relationship with ECA continuation, while green indicates the negative intensity of the relationship.

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 if 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 that also focused on knowing the ECA interest of farmers in Fujioka, Japan. The Japanese farmers exhibited very high biodiversity conservation awareness and identified improving their local and global environment as their main reason to continue ECA; however, their ECA interest is low [13]. 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 [56]. 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. Cognitive dissonance can be reduced by distributing easy-to-understand information regarding ECA and how it can mitigate climate change. 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 with leaders in the farming community whom the farmers highly respect and trust, they can reassure their co-farmers that their ECA understanding is correct, and post-decision 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 negatively affects their ECA continuation. Furthermore, being advised by JA lessens their likelihood of strengthening their ECA adoption. 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). These strategies may reduce the farmers' cognitive dissonance and 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 [57]. 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.

5.2. Negative Impact of Subsidies to ECA Continuation

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 encouraged the adoption of conservation agriculture [58]. 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 [59]. 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 tend to hinder farmer participation [60].

In addition, the cost of subsidy compliance, as well as administrative and transaction costs, have been found to deter farmer participation [61,62]. 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 was 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 [13].

In the 2003 report of the Organization for Economic Cooperation and Development on environmentally harmful subsidies, it was highlighted that subsidies that scale with production are more likely to be environmentally harmful when compared with direct payments decoupled from farm output [63]. 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 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 [64]. From another perspective of subsidy, various studies have associated conservation agriculture as a risky investment due to difficulties in accessing insurance, the need for farmers to learn new farming techniques, and the return of investment that may reach up to four years or more [65,66]. In addition, it was also shown that in some countries, financial support policies have proven insufficient to drive ECA implementation [38,67,68]. Hence, other incentives should be explored aside from subsidies to encourage ECA adoption and continuation in Japan, as discussed earlier.

5.3. ECA's Environmental and Economic Sustainability

When asked about their opinion on ECA's sustainability, the farmers had mixed opinions, especially regarding this farming method's environmental and economic sustainability. 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 is better community participation and joint efforts between consumers and producers. Since the inclusion of 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 [41,69,70]. 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 [15]. 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 farmer testimonials:

> "*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*."

On the negative side, the farmers are emphasizing that while ECA's adoption is possible, it does not currently present economic merits. Several studies have already established that farm income can enhance farmers' adoption of agricultural technologies [71–73]. In this case, 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 [74,75]. 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. Therefore, a study focusing on this aspect is recommended for future researchers on this topic.

6. 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, both GIAHS sites. This study focused on analyzing the factors influencing the continuation of environmental conservation agriculture (ECA) among Sado Island farmers. 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 4). 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. The positive ECA drivers identified that support this inference are the following: (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 [20].

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 on mitigating climate change. A similar case was documented in Fujioka, Japan [13]. 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 address the existing cognitive dissonance, such as 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 [56] 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). For the continued success of GIAHS and ECA in Sado Island, concerted local 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.

Author Contributions: Conceptualization, K.L.M., C.M.G. and W.J.F.A.; methodology, K.L.M., C.M.G. and W.J.F.A.; software, K.L.M., C.M.G. and W.J.F.A.; validation, K.L.M., C.M.G. and W.J.F.A.; formal analysis, K.L.M., C.M.G. and W.J.F.A.; investigation, K.L.M.; resources, K.L.M.; data curation, K.L.M., C.M.G. and W.J.F.A.; writing—original draft preparation, K.L.M., C.M.G. and W.J.F.A.; writing—review and editing, K.L.M., C.M.G. and W.J.F.A.; visualization, K.L.M., C.M.G. and W.J.F.A.; supervision, K.L.M.; project administration, K.L.M.; funding acquisition, K.L.M. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the Japan Society for Promotion of Sciences (JSPS); JP JSBP 120197904.

Institutional Review Board Statement: The study was conducted according to the guidelines of the Declaration of Helsinki and approved by the Ethics Committee of Graduate School for International Development and Cooperation, Hiroshima University, on 10 July 2020.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study in the annual meeting of the Board of Directors of the Council for Promotion of "Toki-to-kurasu-satozukuri" (Community development living in harmony with Toki).

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

Acknowledgments: This paper is part of the findings of the joint research project, "Moving Towards Climate Change Resilient Agriculture: Understanding the Factors Influencing Adoption in India and Japan", Principal Investigator: Keshav Lall Maharjan, funded by the Japan Society for Promotion of Sciences (JSPS); JP JSBP 120197904. The authors would like to thank the members of the project, Akinobu Kawai, by special appointment, The Open University of Japan and Akira Nagata, Visiting Research Fellow, United Nations University, Institute for the Advanced Study of Sustainability, Japan, for their valuable inputs in the conceptualization of the research project, constructing the questionnaire, and conducting the survey. The authors are also thankful to Shinichiro Saito, Chair, Board of Directors, and the members of the "*Toki-to-kurasu-satojukuri suishin kyogikai*" (Council for Promotion of Community Development Living in Harmony with Toki) and Sado Municipality Agriculture Policy Division for their cooperation in conducting the survey. The authors are grateful to Ruth Joy Sta. Maria for her expertise in the creation of figures for this paper. The earlier version of this paper was presented orally at the *International Conference of Agricultural Economists,* 17–31 August 2021, online. The authors and funding agency have no conflict of interest.

Conflicts of Interest: The authors declare no conflict of interest.

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