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Dynamics of Environmental Conservation Agriculture (ECA) Utilization among Fujioka Farmers in Japan with High Biodiversity Conservation Awareness but Low ECA Interest

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Abstract: Japan aims to be carbon-neutral by 2050 by targeting various sectors including agriculture. One of the main strategies in this sector to mitigate climate change effects is environmental conservation agriculture (ECA); however, ECA utilization remains low in most of Japan's prefectures to this date. To address this problem and to know what factors influence ECA adoption, we collected data from Fujioka city, Gunma prefecture, which has low ECA utilization but has high biodiversity conservation efforts. Using factor analysis and binary logistic regression, two major themes emerged by which ECA continuation can be increased, namely: farmers' intent to improve their local/global environment and to enhance their production. The study highlighted the importance of ECA information dissemination as evidenced by the presence of a knowledge gap on how ECA translates into climate change advocacies. The promotion of farmer-consumer market channels and extension of ECA products in local industries by government and non-government institutions are also recommended to strengthen rural-urban linkages in the area. Increasing the ECA uptake of farmers would also have a positive impact on the ongoing preservation of endangered *yaritanago* fish species in Fujioka. Lastly, the results from this study highlight the heterogeneity of factors that affect any given farming community with respect to the strategies that can effectively drive ECA adoption.

Keywords: environmental conservation agriculture; biodiversity conservation; Fujioka; *yaritanago*; environmental concern; sustainable agriculture; climate change

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1. Introduction

The link between agriculture and climate change has been well-established for the past decades, with negative far-reaching consequences coming from greenhouse gas (GHG) emissions, impacts on biodiversity, and land degradation, among others [1–3]. From 2007 to 2016, around 23% of the world's GHG emissions came from agriculture, forestry, and other land uses (AFOLU) [4]. Agriculture is one of the main drivers of climate change and many interventions will be necessary to reduce its role in going beyond the planetary boundaries [5]. Likewise, climate change negatively affects agricultural systems globally, which contributes to yield losses and thereby poses more challenges in feeding an escalating population that will reach the 10 billion mark by 2050 [6,7].

For the fiscal year (FY) 2019, Japan's total GHG emissions were 1212 million tons—a 14% reduction from the FY 2013 benchmark and the country's sixth straight year of lowering emissions. This shows that Japan is on track with its commitment to the United Nations Climate Change Convention to cut its emissions by 26% from 2013 levels by 2030. The country also ambitiously aims to be carbon neutral by 2050. For FY 2019, 47.47 million tons of GHGs were produced by Japan's agriculture, forestry, and fisheries sector, accounting for 3.9% of the total emissions [8]. To reduce this, one of Japan's strategies is to support environmental conservation agriculture (ECA) activities, such as by giving direct payment subsidies to farmers practicing ECA and promoting organic farming. Simply put, ECA is a type of agriculture that contributes to the conservation of the natural environment, which is also termed environmentally friendly agriculture. ECA has a broader focus than the widely known conservation agriculture (CA) defined by the Food and Agriculture Organization (FAO), which focuses on three key principles (i.e., no-till, crop rotation, and residue retention) [9]. ECA has a wider and more flexible scope as compared to CA, which allows different forms of farming to be classified under it, such as organic farming, special farming (uses 50% less pesticide and fertilizer than conventional 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), thereby enabling more farmers to be supported. A more specific definition of ECA was given by the Ministry of Agriculture, Forestry, and Fisheries (MAFF) in 1994, which is "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" [10]. MAFF (2020) reported that around 140,000 tons of GHGs are being reduced per year through the activities supported by ECA direct payments [11]; hence, increasing ECA adoption in Japan should be prioritized to aid in the country's pledge to be carbon neutral by 2050.

Various papers have reported that adopting climate-friendly agriculture methods and conservation measures can mitigate GHG emissions [12–14]. Such practices include reducing tillage, eliminating fallow, removing or reducing the use of chemical pesticides and fertilizers, manipulating manure management practices and animal diet, avoiding over-application and usage of split nitrogen to meet plant needs, implementing an integrated farming system, and covering the soil with perennial vegetation, residue, or cover crops. All these practices are included in ECA's scope which extends its role in mitigating climate change, most especially in Japan. In terms of biodiversity conservation, ECA methods led to the designation of Sado Island as a Globally Important Agricultural Heritage System (GIAHS), most especially because they helped to protect the endangered Toki birds (*Nipponia nippon*) [15]. This will be discussed in detail in the following section. This study also explored ECA's role in biodiversity conservation, particularly on the endangered *yaritanago* (*Tanakia lanceolata*) fish in Fujioka city, Gunma prefecture.

Japan's prefectures have low ECA utilization (ECA area based on direct payment subsidies divided by each prefecture's total cultivated land) according to MAFF's 2016–2020 reports (Figure 1). This finding agrees with Miyake et al. (2022) who stated that ECA's development is still in its early stage in Japan [16]. In 31 out of 47 prefectures (65.9%), a decreasing trend was observed for the percentage of ECA utilization. The biggest decline came from Shiga prefecture (from 32.8% in 2016 to 25.3% in 2020), which is the leading prefecture when it comes to ECA utilization. Shiga has a leading role when it comes to implementing agri-environmental policies to protect Lake Biwa, which is Japan's largest lake, and was proven to be a successful case. The implementation of ECA methods and agri-environmental policies significantly reduced the pollution in Lake Biwa. Furthermore, ECA adoption raises the willingness of Japanese farmers to expand their farm size, implement direct marketing, and increase the number of their market channels, which may improve the efficiency and structure of Japanese agriculture [17]. The data in Figure 1 shows that more efforts are needed in Japan to increase the ECA adoption rate among farmers. The percentage reported may still increase if other ECA farmers who did not apply for direct payment subsidy can be included; however, there is no available statistical data for that yet. Given the premise of declining ECA utilization in Japan, this paper thus aims to report the factors affecting ECA adoption of farmers in a prefecture with low ECA utilization (only 0.25% as of 2020) and decreasing ECA utilization from 2016 to 2020, specifically Gunma prefecture.

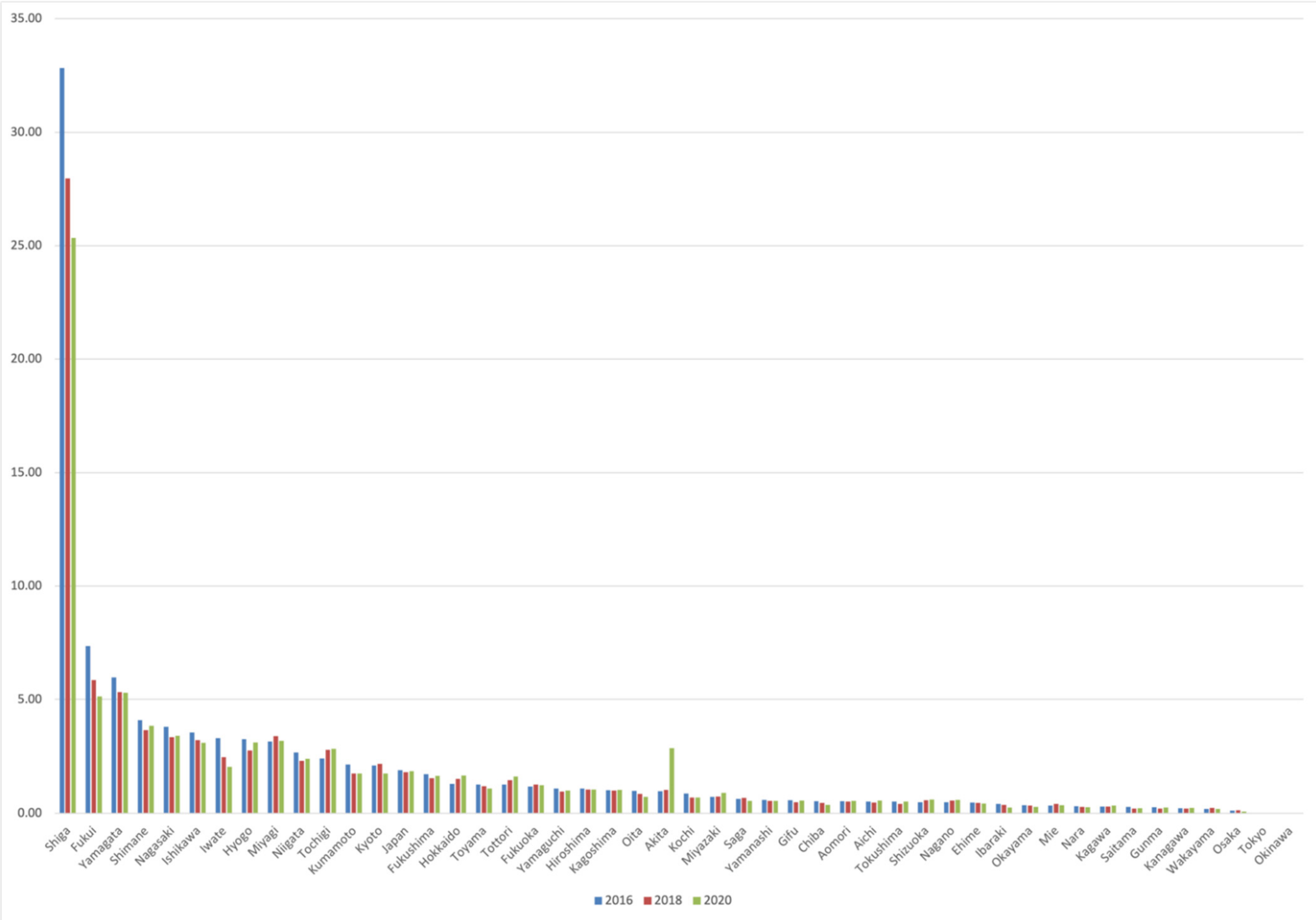

Figure 1. Percentage of ECA utilization in Japan.

Figure 2 shows a clearer perspective regarding the ECA utilization of each prefecture in Japan (ECA area based on direct payment subsidies divided by each prefecture's total cultivated land). Here, we observed that only three prefectures in Japan have greater than 5% ECA utilization in 2020, namely: Fukui (5.1%), Yamagata (5.3%), and Shiga (25.3%). This data also shows that Gunma prefecture, to which Fujioka city belongs (chosen research locale of the study), is the sixth least in percent ECA utilization (0.25%). Interestingly, prefectures with at least 1% ECA utilization appear to be situated along the western coastal line of Japan, while those that have marginal (<1%) ECA utilization are found on the eastern side. Although we could infer that this may be due to the urban-rural distribution of the prefectures, further exploration regarding the forces that drive this spatial pattern for ECA utilization, however, is well beyond the scope of this paper.

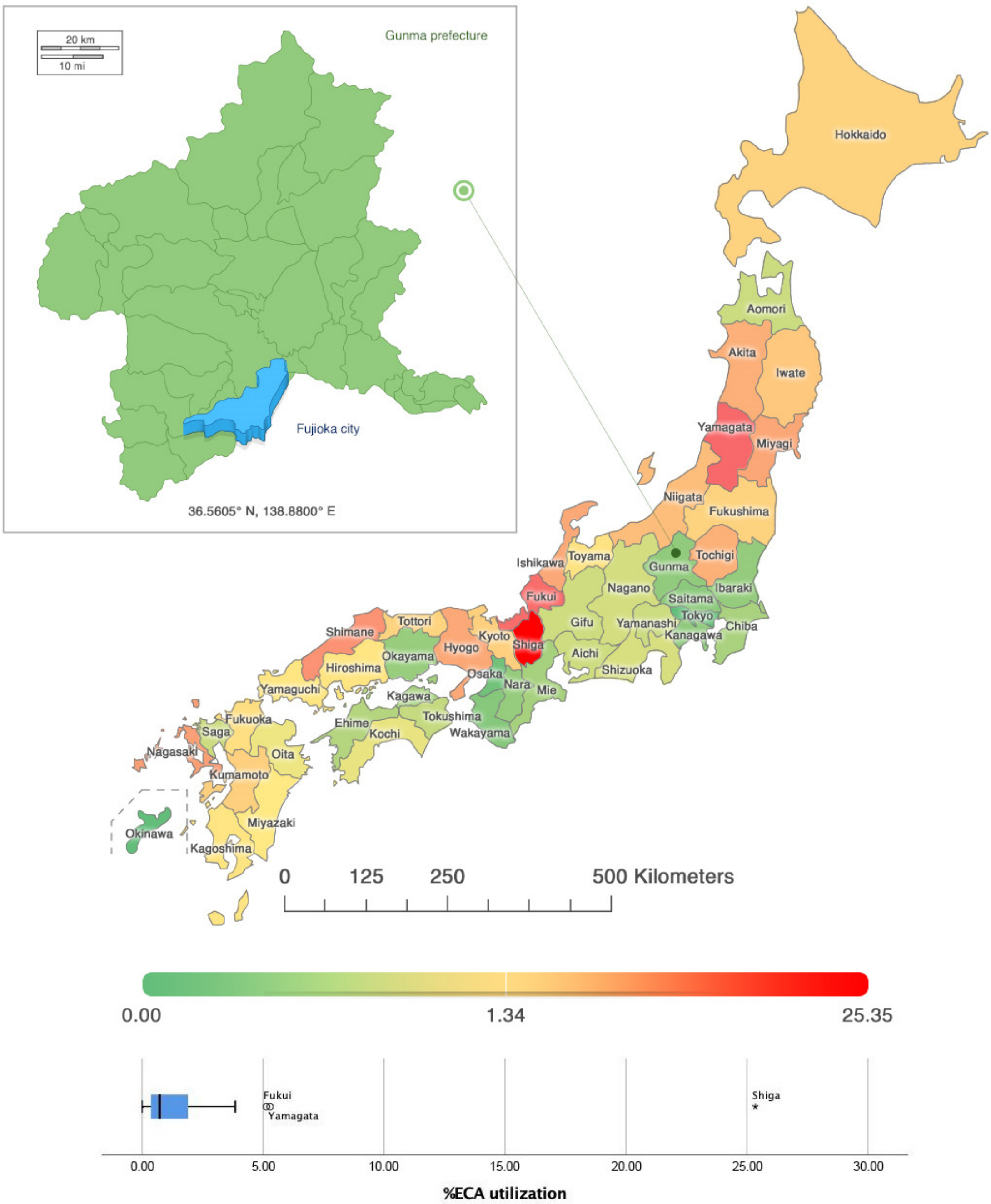

Figure 2. Heatmap showing percentage of ECA utilization per prefecture in Japan and Fujioka city in Gunma prefecture (chosen research locale).

1.1. Sustainable Agriculture and Biodiversity Conservation in Japan

For the past decades, Japan has been active in promoting biodiversity conservation and sustainable agriculture, which is why it currently has a total of 11 Globally Important Agricultural Heritage Systems (GIAHS) designated by FAO [15]. Japan has been proactive in preserving endangered species, such as butterflies [18], vascular plants [19], and birds [20]. Fujioka city in Gunma prefecture is also active in biodiversity conservation, which primarily aims to save rare species including the *yaritanago*. The *yaritanago* is an indigenous, freshwater carp that is classified as near-threatened (NT) in Gunma Prefecture's Red List or endangered animals. This was caused by several reasons such as habitat loss, water pollution, alterations in irrigation systems, biological invasion, and the decline of freshwater mussels where the fish breed by depositing their eggs [21,22]. Gunma prefecture used to host various types of indigenous fish decades ago, including carps in river systems or waterways among the farmlands. The construction of concrete water canals for irrigation of paddylands after the 1950s destroyed most of the habitats of these fish and led to the extinction of many species in the 1980s. The *yaritanago* was thought to be extinct in Gunma for more than a decade until an angler in Fujioka city discovered it accidentally in 1998. Since then, the citizens of Fujioka city have been trying to save the *yaritanago*, which is well-supported by the local government. It was even designated as Fujioka city's national treasure. In 2001, with the formulation of a national law to build environmentally friendly water canals, the city invested more efforts to protect the *yaritanago's* habitats, which led to the population increase of the endangered carp [23]. It is vital to conserve the agricultural canal networks, not only for the *yaritanago* but also for other species, such as the freshwater mussels *matsukasagai* (*Pronodularia japanensis*) on which the carp lay their eggs [22]. Environmental conservation agriculture (ECA) can positively contribute to this biodiversity conservation; hence, this paper aims to know what factors can increase the Fujioka farmers' adoption of ECA.

The case of Sado island's Toki birds is a good example of ECA's positive impacts on preserving biodiversity. Sado island in Niigata prefecture is one of the first GIAHS in Japan and among developed countries. GIAHS is defined by FAO as "*remarkable land-use systems and landscapes which are rich in globally significant biological diversity evolving from the co-adaptation of a community with its environment and its needs and aspirations for sustainable development*" [24]. Due to Sado island's satoyama and satoumi landscapes, it is known as the natural habitat of endangered Japanese crested ibises (locally called Toki in Japanese). The paddylands serve as the habitats of the Toki birds, which is why Sado island is also famous for its rice produce with Toki branding [25]. This case shows a similarity with the biodiversity conservation efforts being carried out in Fujioka city and presents a possible future if these efforts will continue. It was reported that farmers in Sado island who give high value to biodiversity conservation feel more involved with GIAHS [15], therefore highlighting the importance of this factor in increasing farmer participation for environmentally friendly and sustainable agriculture initiatives.

1.2. Factors Affecting Farmers' Adoption of Environmental Conservation Agriculture Methods

In line with the profound contribution of the agricultural sector to the global GHG emissions [26], numerous scholars have analyzed the factors affecting farmers' adoption of methods that aim to mitigate climate change [27,28]. In a meta-analysis conducted by Mozzato et al. (2018) in developing and developed countries, several classifications of these influential factors have been defined, which focus on the farmer, the farm, as well as information, social, value-chain, and spatial factors [28]. It was observed that reports from different papers gave contrasting results due to differences in geographical contexts and varying levels of adoption. Meanwhile, Dessart et al. (2019) classified farmers' influential factors based on their proximity to the decision to adopt specific sustainable practices [27]. They were placed in a distal-proximal spectrum and were categorized as dispositional, social, and cognitive factors. Like the findings of Mozzato et al. (2018), the factors were observed to vary on a case-by-case basis. All these meta-analyses agree with Barlett (1980) who argued that farmers exhibit heterogeneity based on their area, farming context, community, among others, which imply that policies should be crafted on a bottom-up basis, and that future papers on this topic would vary per context as well [29].

In Japan, some scholars also determined factors affecting farmers' adoption of environmental conservation agriculture methods. Farmers' attitudes, risk preference, and farm size were found to be correlated with Shiga farmers' ECA adoption [17]. In Niigata prefecture, ECA farmers' involvement in GIAHS increases when GIAHS improves tourism management, youth involvement, and product branding [15]. Meanwhile, the satisfaction being derived from fellowship with co-ECA farmers in Ishikawa was found to be positively correlated with income change; hence, improving support networks of farmers is also being recommended [16]. Most of the ECA literature in Japan focused on areas with relatively high ECA uptake, such as Shiga, Niigata, and Ishikawa prefectures; however, there is still a lack of papers reporting ECA adoption in areas with low ECA utilization. Furthermore, only a few papers are discussing the dynamics of incorporating ECA with biodiversity conservation in Japan.

2. Study Area and Methods

Since this paper aims to know the factors affecting the ECA adoption of farmers in an area with a low percentage of ECA utilization and active biodiversity conservation initiatives, Fujioka city was selected as the study area (Figure 2). It is located on the southern border of Gunma prefecture and has an abundant natural environment, mountains with vast greeneries, clear running streams, and seasonal flowers such as the winter cherry blossoms and Japanese wisteria. With its mild climate, a lot of fruits, vegetables, and agricultural crops are being grown, such as rice, strawberries, tomatoes, apples, pears, mandarin oranges, and blueberries [30]. The city is also known for its biodiversity conservation efforts to save endangered species including the *yaritanago.* However, in terms of agricultural data, Fujioka's total number of farmers decreased from 1985 in 2005 to 1798 in 2015. Consequently, the total area for cultivated land also decreased from 1133 ha in 2005 to 1066.9 ha in 2015. It also has a low and decreasing ECA utilization from 2016–2020 (Figures 1 and 2).

A questionnaire survey was employed in Japanese to collect data from farmers in Fujioka city regarding their ECA adoption. In September 2019, key informant interviews with the Fujioka city environmental groups and users of environmentally friendly water canals were held with the support of the local government to know the current situation and issues in the area. The questionnaire was approved by the research ethics committee of the Graduate School of International Development and Cooperation, Hiroshima University. Its contents were then explained to the key informants, who then explained them to the respondents. Consent was obtained from all the respondents for their participation in this research. The questionnaires were distributed to the Fujioka farmers belonging to various environmental groups and users of environmentally friendly water canals from October to November 2019, and key informant interviews were conducted again in February 2020 to verify the gathered data. Out of the 80 questionnaires distributed, a total of 46 (57.5%) responses were received. The contents of the questionnaire include: (1) socio-demographic and farm-related information of the farmers; (2) ECA-related opinions; (3) climate change perception and adaptation; (4) ECA's significance and its relationship to climate change; (5) ECA adoption and expectations on its effects; (6) ECA farmers' receiving of subsidy; and (7) prospects of Fujioka city towards ECA. ECA- and climate-change-related questions were adopted from MAFF [31–33]. All the responses that are in local Japanese were translated to English by the authors.

Data were analyzed using principal component analysis and binary logistic regression in SPSS v.25. Model fitting was performed to assure that the statistical assumptions are met. Since ECA-related variables appear to converge on a common theme, we inferred that there might be underlying latent factors that tie these common variables together. To confirm this, we employed factor analysis of the socio-demographic, ECA-related, and climate-change-related variables which reduced them into eight latent factors, namely: ECA farming method (Factor 1), assets (Factor 2), ECA continuation (Factor 3), immediate effects of climate change (Factor 4), weather effects of climate change (Factor 5), climate change and production variables (Factor 6), farming experience (Factor 7), and damage effects of climate change (Factor 8). Qualitative information was also gathered and was used for thematic analysis.

3. Results

3.1. Socio-Demographic and ECA-Related Variables of Fujioka Farmers

We characterized the farmers in Fujioka, Gunma, Japan in terms of socio-demographic and ECA-related variables. In agreement with previous studies [34,35], we also observed that more than half of the Fujioka farmers in this study are at least 65 years old (58.7%), and are mostly classified as family farms (93.5%) with the purpose of selling (54.3%) and self-consumption (43.5%) (Supplementary Table S1). Half of them have no other family member whose main job is not farming, although they could lend a helping hand to the farmers during peak seasons. Only almost one-third (30.4%) have one family member whose main job is farming. The low number of farmers who reported conducting ECA farming (45.7%) in Fujioka reflects the national data for %ECA utilization in Gunma prefecture.

In terms of ECA-related variables, ECA interest is low for most of the interviewed farmers (63.0%) as further evidenced by the high number of farmers who are not interested in learning about ECA opportunities (73.9%) (Supplementary Table S2). Unsurprisingly, less than one-third (23.9%) of the farmers reported that they would continue ECA farming and 43.5% wanted to retain the same farming area and methods. The top reasons for those who would continue ECA farming are to improve the local and global environment (30.4%) and to supply better products (23.9%). Meanwhile, the farmers' top three expectations from ECA are conservation of biodiversity (39.1%), adding value to the quality of products (39.1%), and conservation of water quality (23.9%). Most of the farmers (84.8%) have never received ECA subsidies and do not participate nor promote exchange programs with local residents or consumers (82.6%). For those who participate, direct sale to consumers and harvesting (17.4%) and schoolchildren's extracurricular activities (17.4%) were the top exchange programs chosen.

While the farmers' disposition towards ECA may be low, more than half (60.9%) answered that climate change has a very high impact on agriculture (Supplementary Table S3). The top perceived effects of climate change are the following: increase in temperature and extremely hot days (76.1%), heavy torrential rain; flooding (60.9%), and change in season duration (52.2%). The top adaptations being carried out for these perceived effects are planting high temperature-tolerant varieties (47.8%) and water management (41.3%).

3.2. Factor Analysis of Socio-Demographic and ECA-Related Variables

There were eight latent factors that emerged in the factor analysis (Table 1). As expected, farming method is strongly correlated with ECA farming method (Factor 1), as well as ECA continuation and the farmers' intent to improve their local and global environment. ECA farming method (Factor 1) is correlated with ECA continuation (Factor 3), because of *building trust with consumers*, *self-health*, and *supplying better products*. It can also be seen that ECA continuation (Factor 3) is strongly correlated with *good/high price* and *high demand*, which shows that aside from environmental considerations, the farmers might also be ascribing high importance to the economic value of their products. In addition, farmers with high assets (Factor 2) are predisposed to have a high ECA farming method (Factor 1), due to *ECA interest*. Within Factor 2, ECA interest appears to be negatively associated with *damage to houses/buildings* and *damage to land/farmland*, and positively associated with *selling*. In addition, *ECA interest* and *ECA opportunities* also predisposes farmers with high climate change and production variables (Factor 6) to engage more in ECA farming method (Factor 1).

The climate change variable *typhoons*, *cyclones*, or *tornadoes* is associated with immediate effects of climate change (Factor 4), weather effects of climate change (Factor 5), and climate change and production variables (Factor 6). Farming experience (Factor 7) appears to be negatively related with farmers' interest to discuss or learn about ECA opportunities. In Factor 8, the farmers' opinion that climate change has a very high impact on agriculture increases due to *damage to houses/buildings* and *damage to land/farmland*.

Table 1. Exploratory factor analysis [a] of the variables observed among farmers in Fujioka, Japan.

Factor	Eigenvalue
Factor 1: ECA farming method	
ECA interest	0.595
ECA opportunities	0.580
ECA continuation	0.740
Farming method	0.802
Melting of glaciers, sea-level rise	0.324
To build trust with consumers	0.557
To improve local and global environment	0.824
Self-health	0.498
To supply better products	0.403
Factor 2: Assets	
ECA interest	0.332
Damage to houses/buildings	−0.398
Damage to land/farmland	−0.318
Self-consumption	−0.898
Selling	0.886
Factor 3: ECA continuation	
To build trust with consumers	0.440
Self-health	0.426
Good/high price	0.853
High demand	0.778
Want to supply better products	0.451
Factor 4: Immediate effects of climate change	
Heavy torrential rain; flooding	0.310
Typhoons, cyclones, or tornadoes	0.322
Change in season duration	−0.442
Melting of glaciers, sea-level rise	0.448
Damage to houses/buildings	0.546
Damage to land/farmland	0.305
Damage to farm products	0.797
Want to supply better products	0.339
Factor 5: Weather effects of climate change	
Heavy torrential rain; flooding	0.668
Increase in temperature and extremely hot days	0.694
Typhoons, cyclones, or tornadoes	0.507
Drought	0.524
Factor 6: Climate change and production variables	
ECA interest	0.332
ECA opportunities	0.377
Typhoons, cyclones, or tornadoes	0.331
Change in season duration	−0.340
Melting of glaciers, sea-level rise	−0.393
Decrease production cost of fertilizers and pesticides	0.723
Company farm	0.656
Factor 7: Farming experience	
Interest to discuss or learn about ECA opportunities	−0.274
Age	0.826
Farming experience	0.908
Factor 8: Damage effects of climate change	
Climate change has a very high impact on agriculture	0.826
Damage to houses/buildings	0.419
Damage to land/farmland	0.510

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

3.3. Associations with ECA-Related Factors

To complement the various themes observed using the factor analysis, we tested the association of *farming method*, *ECA continuation*, *ECA interest*, and *ECA opportunities* with other factors. Since ECA and climate change are closely connected [36,37], we first explored the relationship between *farming method* and perceived *climate change effects* identified by the Fujioka farmers using binary logistic regression (Table 2).

Table 2. Relationship of climate change and ECA-related variables with farming method.

Variable	Estimate	Odds Ratio	Significance
Perceived climate change effects [a]			
Heavy torrential rain; flooding	−0.053	0.948	0.944
Increase in temperature and extremely hot days	0.278	1.321	0.761
Change in distribution of plants/crops	−1.787	0.167	0.068
Change in season duration	1.789	5.986	0.031 *
Melting of glaciers, sea-level rise	1.933	6.914	0.046 *
Drought	−0.228	0.796	0.789
Damage to houses/buildings	−0.354	0.702	0.849
Damage to land/farmland	0.226	1.254	0.827
Damage to farm products	0.195	1.216	0.829
Selling place [b]			
Direct to consumers	1.829	6.225	0.048 *
Supermarket	−20.337	0.000	0.999
Restaurant	20.629	-	0.999
Agricultural corporations	0.940	2.560	0.300
Central market	0.491	1.634	0.744
Michi-no-eki (roadside farmers' market)	−1.312	0.269	0.368
Food processors	20.014	-	0.999
Reason for ECA continuation [c]			
To build trust with consumers	2.056	7.818	0.199
To improve local and global environment	4.197	66.459	0.007 **
Self-health	0.809	2.246	0.517
Good/high price	35.343	-	1.000
High demand	−18.056	0.000	1.000
To supply better products	−1.835	0.160	0.248
To decrease production cost of fertilizers and pesticides	2.235	9.351	0.218

* significant at $p < 0.05$; ** significant at $p < 0.01$. [a] Hosmer-Lemeshow goodness-of-fit: Chi-square = 7.858, df = 6, sig = 0.249. [b] Hosmer-Lemeshow goodness-of-fit: Chi-square = 1.031, df = 5, sig = 0.960. [c] Hosmer-Lemeshow goodness-of-fit: Chi-square = 2.571, df = 4, sig = 0.632.

Farming method is positively associated with *change in season duration* and *melting of glaciers and sea-level rise* which increases the odds of the farmers employing ECA farming by 6 times and 6.9 times, respectively. In terms of selling place, *direct to consumers* increased the odds of farmers employing ECA farming by 6.2 times. Notably, *to improve local and global environment* was the only reason for ECA continuation that significantly increased the odds of Fujioka farmers to use ECA farming by ~66 fold.

We also used the same independent variables with *ECA continuation* as the dependent variable (Table 3). Using binary logistic regression, we identified *damage to land/farmland* as a factor affecting ECA continuation. Specifically, farmers who perceive *damage to land/farmland* as a climate change effect are more likely to continue ECA by ~23 fold. Here, *direct to consumers* was also identified as a selling place which increases the odds of continuing ECA by ~15 fold. Looking at ECA continuation relationships with reason for ECA continuation identified *to improve local and global environment* and *decrease production cost of fertilizers and pesticides* as significant factors. Both increase the odds of ECA continuation among Fujioka farmers by ~12 fold and ~43 fold, respectively.

Table 3. Relationship of climate change and ECA-related variables with ECA continuation.

Variable	Estimate	Odds Ratio	Significance
Perceived climate change effects [a]			
Heavy torrential rain; flooding	0.949	2.584	0.349
Increase in temperature and extremely hot days	0.229	1.257	0.862
Change in distribution of plants/crops	−0.576	0.562	0.587
Change in season duration	1.520	4.572	0.139
Melting of glaciers, sea-level rise	0.145	1.156	0.898
Drought	−0.443	0.642	0.674
Damage to houses/buildings	1.202	3.325	0.541
Damage to land/farmland	3.137	23.041	0.037 *
Damage to farm products	−3.148	0.043	0.091
Selling place [b]			
Direct to consumers	2.752	15.674	0.040 *
Supermarket	−18.409	0.000	0.999
Restaurant	20.484	-	0.999
Agricultural corporations	−0.637	0.529	0.660
Central market	−17.281	0.000	0.999
Michi-no-eki (roadside farmers' market)	−0.769	0.464	0.677
Food processors	21.091	-	0.999
Reason for ECA continuation [c]			
To build trust with consumers	2.384	10.846	0.086
To improve local and global environment	2.501	12.198	0.029 *
Self-health	1.812	6.122	0.124
Good/high price	35.709	-	0.999
High demand	−17.002	0.000	1.000
To supply better products	−0.878	0.416	0.501
To decrease production cost of fertilizers and pesticides	3.779	43.788	0.041 *

* significant at $p < 0.05$. [a] Hosmer-Lemeshow goodness-of-fit: Chi-square = 9.237, df = 7, sig = 0.236. [b] Hosmer-Lemeshow goodness-of-fit: Chi-square = 1.770, df = 5, sig = 0.880. [c] Hosmer-Lemeshow goodness-of-fit: Chi-square = 1.383, df = 4, sig = 0.847.

Next, we explored associations that exist for ECA interest (Table 4). The variables *to improve local and global environment* and *promote local industry* were found to increase farmers' interest in ECA by ~10 fold.

Table 4. Relationship of ECA expectation and reason for ECA continuation with ECA interest.

Variable	Estimate	Odds Ratio	Significance
ECA expectation [a]			
Carbon sequestration	−22.563	0.000	0.999
Conservation of biodiversity	1.904	6.715	0.107
Conservation of water quality	−0.652	0.521	0.599
Retain underground water	21.522	-	0.999
To add value to quality of products	1.996	7.357	0.083
Decrease effect of weather hazards	−0.360	0.698	0.839
Increase farm related income	−1.526	0.218	0.226
Promote local industry	2.342	10.403	0.047 *
Retain residents in rural area	−1.370	0.254	0.464
Reason for ECA continuation [b]			
To build trust with consumers	0.541	1.718	0.676
To improve local and global environment	2.397	10.985	0.007 **
Self-health	0.367	1.443	0.734
Good/high price	−45.710	0.000	0.999
High demand	22.549	-	1.000
To supply better products	0.361	1.435	0.735
To decrease production cost of fertilizers and pesticides	1.652	5.219	0.263

* significant at $p < 0.05$; ** significant at $p < 0.01$. [a] Hosmer-Lemeshow goodness-of-fit: Chi-square = 4.521, df = 5, sig = 0.477. [b] Hosmer-Lemeshow goodness-of-fit: Chi-square = 4.429, df = 4, sig = 0.351.

Lastly, we explored associations for farmers' interest to discuss and learn about ECA opportunities (Table 5). *Conservation of biodiversity* is the only variable that increases the odds of participating in ECA opportunities, which agrees with the environmental activism and *yaritanago* preservation happening in Fujioka.

Table 5. Relationship of ECA expectation and selling place with ECA opportunities.

Variable	Estimate	Odds Ratio	Significance
ECA expectation [a]			
Carbon sequestration	−21.827	0.000	0.999
Conservation of biodiversity	5.532	252.546	0.015 *
Conservation of water quality	0.975	2.652	0.555
Retain underground water	17.563	-	0.999
To add value to quality of products	0.639	1.894	0.697
Decrease effect of weather hazards	−0.229	0.795	0.916
Increase farm related income	2.232	9.314	0.216
Promote local industry	−2.391	0.092	0.164
Retain residents in rural area	2.183	8.876	0.209

* significant at $p < 0.05$. [a] Hosmer-Lemeshow goodness-of-fit: Chi-square = 4.047, df = 5, sig = 0.543.

4. Discussion

Fujioka city in Gunma, Japan presents an interesting avenue to study environmental conservation agriculture diffusion among farmers and its interaction with local industries. Fujioka does not have enough agricultural yield to rank highly in terms of agricultural output, but the distinct presence of environmental activism within the city makes it a good target for Japan for climate change policies. Our current data further verifies this statement by showing a high proportion of Fujioka farmers who perceive significant effects of climate change (60.9%). However, our data also shows that farmers in Fujioka do not appear highly interested nor engaged in environmental conservation agriculture, which mirrors the %ECA utilization of Gunma (Figure 1). Thus, we aimed to leverage the unique position of Fujioka farmers in the context of ECA to highlight critical factors that can aid in the diffusion of ECA farming in the area.

Dessart et al. (2019) categorized behavioral factors affecting farmers' adoption of sustainable practices into three clusters, namely cognitive, social, and dispositional factors arranged in increasing distance relevant to farmer decision-making [27]. We have observed similar themes in terms of ECA adoption among Fujioka farmers which encompass aspects of perceived costs and benefits, knowledge, and environmental concern. Using factor analysis, we found that ECA continuation is positively correlated with *good price*, *high demand*, and *self-health*. In addition, regression analysis also identified reduced production cost of fertilizers and pesticides as a significant factor that promotes ECA continuation among the Fujioka farmers. While some studies show that ECA may give added profit to farmers [38], other studies show that ECA does not appear profitable enough to support *good price* and *high demand* as factors affecting ECA continuation [39]. Some interviewed farmers are also voicing this out:

> "*ECA farming needs lots of time and hands-on effort. It also can't produce better or more profitable products [than conventional farming].*"

Targeting ECA profitability to diffuse ECA among Fujioka farmers is supported by the slightly higher proportion of farmers with the intent of selling (54.3%) compared to self-consumption (43.5%). The following testimonials of the interviewed farmers reflect the farmers' perspectives regarding the sustainability of ECA at the farm level:

> "*ECA farming is good enough so I will continue adopting it, but it will not be sustainable if we do not market the products with added value; hence, there is a need to establish marketing channels and improve the consumers' understanding of ECA products.*"

> "*As a producer, if you can't make a profit, then your farming method is not sustainable. Both environmental conservation and farm management & profitability should go side by side.*"

These sentiments align with the arguments of other studies which showed that prioritizing environmentally friendly practices—which can be beneficial in the long term—will be difficult when farmers are resource-constrained and suffer from net losses or poor agricultural productivity [40,41]. The direct payment subsidies that Japan is giving to ECA adopters can further supplement ECA profitability; however, most of the farmers (84.8%) chose not to apply for these subsidies, caused by several reasons such as the increase in the number of paperwork that needs to be accomplished and the complex administrative process of applying.

Other than production factors, we also identified improvement in the local and global environment as a factor that can enhance ECA continuation which seems to align with the high climate change awareness of the sampled farmers. We, therefore, looked at the degree of interest that Fujioka farmers have towards ECA. Some testimonials of the interviewed farmers highlighted the capability of ECA to mitigate climate change:

> "*So far, production growth in agriculture has been achieved primarily due to increased use of chemical fertilizers, pesticides, and petroleum energy. However, the constraints we face today, such as greenhouse gas emissions from energy use and negative environmental impacts are clearly becoming issues in agriculture. ECA is becoming a more rational way to farm.*"

Based on the regressions, *change in season duration*, *damage to land/farmland*, and *melting of glaciers and sea-level rise* emerged as the critical factors that increase the farmers' ECA farming method and continuation. However, their knowledge of climate change and its effects did not translate to high ECA interest (37.0%) nor participation in ECA opportunities (26.1%). Most of the farmers (82.6%) also do not participate or promote exchange programs. The affective responses of the farmers towards climate change are indeed good predictors of climate change mitigation acceptance [42], although our data has revealed the gap between farmer awareness regarding climate change and knowledge that most agriculture-related climate change mitigation steps are actually under ECA. If this gap could be bridged, not only will farmers benefit from receiving ECA compensation, but the local government and industries could easily act in a more concerted way to promote ECA which is core to agricultural climate change mitigation [10]. As an example, we observed that ECA farming method and ECA continuation are enhanced by farmers opting to sell directly to consumers. Thus, the local government can promote and support these avenues to boost both ECA farmer income and local appreciation of ECA activities. In turn, the farmers' ECA interest increases when ECA promotes their local industry.

Lastly, we found the inverse relationship between farming experience and engagement in ECA opportunities. As the farmers' age and farming experience increase, they tend to be less interested in ECA. The lack of successors and aging are the reasons given by the Fujioka farmers, which agree with the findings of other studies [15,43]. Indeed, in this study, half of the farmers have no other family member whose main job is not farming, although they could lend a helping hand during peak seasons, and only almost one-third (30.4%) have one family member whose main job is farming. This narrative of an interviewed farmer clearly shows this:

> "*Before talking about ECA, it is necessary to think about the current problem of not having successors in agriculture.*"

5. Conclusions and Recommendations

In this study, we sought to identify factors that are relevant to the adoption of ECA in Fujioka city, Japan which presents a contrast between low ECA utilization and high biodiversity conservation initiatives. We provide evidence for this incongruence by showing that Fujioka farmers have a high concern for the impacts of climate change while simultaneously reporting very low interest in ECA. Since ECA directly translates to climate change mitigation efforts, it is therefore necessary to seek factors that can increase its uptake among farmers. To this end, we identified two major themes that have a positive impact to increase ECA uptake and continuation among Fujioka farmers.

First are the production-related factors, such as *good/high price*, *high demand*, and *want to supply better products*. Farm-related income is a well-documented factor that enhances technology adoption in the context of agriculture [44,45]. In the case of Fujioka, we observed that selling directly to consumers increases farmers' ECA uptake, which therefore provides a good reason for the local government to support ECA farmers. The second theme that emerged is the farmers' environmental concern, which is exemplified by their intent to improve the local/global environment. This factor was found to enhance various ECA components, such as ECA adoption, continuation, and interest. This can positively impact the biodiversity conservation efforts being implemented in Fujioka, such as the protection of endangered species such as the *yaritanago*. Such efforts may depict the altruistic nature behind ECA, given that the costs of adopting ECA accumulate at the farmer level but with few benefits to go along with such practices [46,47]. In Japan, the practice of ECA does come with practical benefits for the farmers in the form of direct payment subsidies, which may be used as another tool to further increase ECA adoption; however, reports of difficulties in applying for such subsidies serve as a barrier for this mechanism from being fully effective.

The findings of the study have also shown a cognitive dissonance between farmers' perception of climate change and ECA as a climate change mitigation method. To address this information gap, we therefore recommend information dissemination regarding ECA's climate change mitigation effects. This can also potentially increase ECA uptake among prefectures in Japan. However, ECA's environmental and economic sustainability should be addressed as well to encourage more farmers to adopt it.

We infer that the farmers in this study value the potential long-term benefits of ECA in improving their environment. Such farmer characteristics are important in facilitating the easy uptake of climate mitigation methods/policies. Evident from this study and previous literature is the fact that while the costs of ECA production are shouldered by the farmers, the benefits manifest at the regional/national level [39]. It is therefore critical that we not only bridge the knowledge gap necessary to inform farmers on how ECA helps climate change mitigation, but also financially aid the farmers who shoulder most of the costs to make agricultural climate change mitigation possible.

Considering the findings in this study, we recommend the intensification of ECA information dissemination among rural communities and farmers alike. We also recommend the promotion of farmer-consumer market channels and the extension of ECA products to local industries, which can be conducted by both government and non-government institutions. Both strategies could serve to strengthen the rural-urban linkages in Fujioka city, Japan. Lastly, the data presented here could serve as a basis for intensifying ECA uptake among prefectures in Japan with a low percentage of ECA utilization.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/su14095296/s1, Table S1: Socio-demographic characteristics of the sampled farmers in Fujioka, Japan; Table S2: ECA-related variables of the sampled farmers in Fujioka, Japan. Table S3: Climate change-related variables of the sampled farmers in Fujioka, Japan.

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