付録1

二国間交流事業　共同研究　研究発表実績

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査読付き学術論文（IF 付き）	Maharjan, S. K. and Maharjan, K. L., 2020. “Climate-Smart Agriculture (CSA): A Systematic Assessment and Analysis of Policies/plans and Practices in South Asia, Particularly Focusing on Nepal and India”, *Journal of Contemporary India Studies: Space and Society*, Vol. 10:17-30, 2020-3.
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著書	河合明宣「第九章　押野用水と歩んだ大字東峰須川」真田用水研究会編『沼田藩真田用水群の魅力』上毛新聞社。2020 年 5 月 186-200 項

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論説 Article

Climate-Smart Agriculture (CSA): A Systematic Assessment and Analysis of Policies/plans and Practices in South Asia, Particularly Focusing on Nepal and India

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Abstract: Climate-smart agriculture (CSA) is a promising concept in agriculture to deal with the climate change impacts through innovative policies/plans, approaches, and practices. This study presents the assessment and analysis of the concept, policies, and practices in relation to CSA in South Asia, particularly focusing on Nepal and India. Both countries have different climatic contexts, but most of the farmers rely on rainfall for agriculture, which is the main source of livelihood and food security. This study applied the systematic review of published papers relating to climate policies/plans and CSA practices in Science Direct (SD) and Springer Link (SL) for the period of 2009 to 2019 with specific inclusion and exclusion criteria. It was found that these studies had specifically focused on climate policies/plans and CSA practices chiefly focusing on agriculture and food security in these countries. However, the CSA practices were different based on the local climatic contexts either initiated by farmers themselves or supported by the government, non-government, and other agencies. Farmer-initiated CSA practices were mostly spontaneous, whereas institution-supported practices were planned, guided by the climate policies/plans. However, these policies/plans and practices lacked specific indicators to assess the successes. Many of these practices were common prior to the emergence of the CSA concept and approach. Thus, it is important to define and understand the CSA concept, approaches, and mechanisms through research, development, and promotion at the national as well as local levels.
Key words: climate-smart, agriculture, adaptation, policies and practices, indicators

I Introduction

1 Background

Agriculture is the main source of livelihood and food security in South Asia including Nepal and India since more than 70% of the people, even in the present time, live in the rural areas relying mainly on it. It also contributes significantly in the local and national economy and gross domestic products (GDP) in both countries. However, the contribution has been decreased over the years due to shrunken of agricultural lands for cultivation, reduced agricultural production, change in the livelihood and social security including youth out-migrating from it and many other socio-economic and political reasons and factors. For instance, the agricultural imports have been increased over the years and agricultural lands have been converted to housings and other forms of industries such as brick industries. According to the United Nations Population Fund (2007), the average land per person would be 1.5 ha in 2050, which was 13.5 ha/person in 1950 that reduced to 3.2 ha/person in 2005. Porter et al. (2014) estimated the loss of crop yields (rice-35%, wheat-20%, sorghum-50%, barley-12%, maize-60%) due to ongoing and future climate change, however, it may vary depending on the location, future climate scenarios and projected years. Average total economic losses are estimated to be 8.7% in India and 9.9% in Nepal (Aryal et al., 2019). The loss in agriculture is considered as a huge socio-economic concern in Nepal (Chalise and Naranpanawa, 2016). These losses are mainly due to instability in area, production and yield, lack of effective policies and less adaptive capacities (Sendhil et al., 2018). On the other hand, the demand for food is expected to be increased by 60% by 2050, thus, it needs a radical transformation in production and efficient utilization the available resources with the minimum impacts of climate change (FAO, 2013).

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Practical and location specific adaptations are required to address the climate variability and impacts (Hochman et al., 2017a). The concept of climate-smart agriculture (CSA), thus, emerged in 2009 with triple-win goals of increase in production, adaptation and mitigation, which was first mentioned in the FAO report entitled "*Food Security and Agricultural Mitigation in Developing Countries: Options for Capturing Synergies*" (Lipper and Zilberman, 2018, p.18). It was later redefined and utilized, as appropriate, by different national and international organizations including the individual researchers based on their own contexts. However, the goals or pillars or outcomes of CSA – sustainable growth in agricultural productivity and incomes, improvement in adaptive capacity and resilience and reduction of greenhouse gases – remain consistent (Hochman et al., 2017b). As stated by Gurung et al. (2016), the main purpose of CSA practices is to sustainably increase the productivity and income in agriculture through research, technological advancement and mechanization, product quality assurance, increased investment and policy frameworks. The roles and contributions of United Nations Food and Agriculture Organization (FAO) and Consultative Group of International Agricultural Research (CGIAR) are significant in promoting it as an approach to address the climate impacts and supporting livelihood and food security (Tripathi and Mishra, 2017). Number of international conferences on agriculture, food security and climate change have also emphasized on promotion of CSA approach starting from Hague conference in 2010 (FAO, 2013). CSA is reflected in the Intended Nationally Determined Contributions (INDCs) of 31 countries to minimize the climate change impacts and reducing poverty as well as harnessing environmental benefits (FAO, 2016).

Since its emergence, the concept of CSA has received substantial attention in the policy debates and practices in agriculture and climate science. Agriculture, food security and climate-smart technologies and approaches have been integrated in the climate policies and plans in some ways (Maharjan, 2019). The consequent conferences have been organized in Wageningen International, Netherlands in 2011, University of California, Davis, USA in 2013, Montpelier, France in 2015, Johannesburg, South Africa in 2017 and Bali, Indonesia in 2019 (GACSA, 2019). The conference in 2014 came up with Global Alliance on Climate Smart Agriculture (GACSA), mainly to bridge the policy and science debates into practices of knowledge, enabling environment and investments in CSA (Lipper and Zilberman, 2018). The CSA initiatives and interventions have also begun in the regional and national levels through the organizations of regional and national conferences, seminars/workshops and formulation of policies/plans and CSA practices. The CSA practices in this study include the CSA technologies, approaches, innovations, services and activities carried out by farmers themselves or with the support of institutions to address the adverse impacts of climate change. Some of these practices are specifically guided by the climate change, agriculture and CSA policies and plans. This paper aims to systematically review and analyze the relevant and specific policies/plans and practices in South Asia specifically in Indian and Nepalese contexts particularly referring to the papers published in Science Direct (SD) and Springer Link (SL). Both of these neighboring countries have similar agricultural practices including the cropping patterns, agricultural technologies and public/private investments in addition to the similar geographical and climatic contexts. In fact, many of agricultural commodities are easily imported and exported between the countries formally and informally. Furthermore, Climate Change, Agriculture and Food Security (CCAFS), the research program of CGIAR revealed that both of these countries are in the process of developing climate-smart investment strategies (CCAFS, 2020). Both of these countries have similar contexts in agriculture such as majority of farmers are smallholders, illiterate, marginal and more importantly have the least adaptive capacities (Tripathi and Mishra, 2017).

2 Conceptual framework

We believe climate-smart (either climate related or agriculture related) policies/plans have direct and reciprocal relationships and influences with climate-smart practices/perceptions and relevant people and institutions (Figure 1). We assume that the policies/plans basically guide the strategies/frameworks and programmes/projects. These policies/plans are usually formulated and executed by the people and institutions including policymakers, decision-makers and the concerned

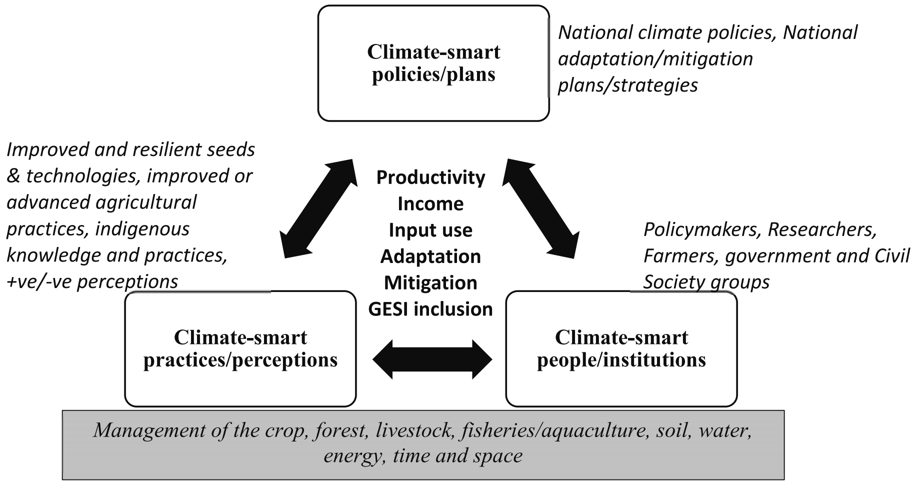

Figure 1 Conceptual framework on inter-relations between CSA policies/plans, practices/perceptions, people/institutions

Source: authors.

stakeholders who have own perceptions, knowledge and understanding towards specific issues that either encourage or impede the programmes/projects to become the practices. Through the joint efforts of policies/plans, practices/perceptions and people/institution, the overarching goals of CSA such as increase productivity, income, and input use efficiency, building resiliency and adaptive capacity, reduce greenhouse gases and presence of successful gender and social inclusion would likely be achieved (Khatri-Chhetri, 2017). The joint efforts need to be focused on efficient management of crops, livestock, forests, fisheries/aquaculture, soil, water, energy, time and space to meet the CSA goals (CCAFS, 2019). New CSA practices and technologies are required to increase the total agricultural production through effective use of resources such as land, labor, water and other financial inputs and investments in the sustainable agriculture (Dunnett et al., 2018). But, many of ongoing agricultural practices are also considered as CSA practices.

All CSA practices are not applicable to all ecosystems and institutional mechanisms and political situations (Thornton et al., 2018). Considering the concepts, this paper has focused on following research questions: 1) What are the relative synergies and trade-offs between policies/plans, practices/perceptions and people/institutions relating to CSA? 2) How effective the policies/plans, practices and institutions in targeting the CSA goals in the selected countries? 3) What are the applicable local/national policies/plans, practices, in the selected countries? 4) What are the possibilities to achieve the investments and institutional supports required to CSA to enhance its adoption? 5) How do we scale out the policy, finance and institutional innovations effectively considering the gender and social dimensions?

Much attentions have been given to CSA since 2009/10 through research, development and innovations at different levels. Number of research papers have been also published in academic and professional journals. This paper concentrates on systematic review of those journal papers published in SD and SL, especially focusing on CSA in South Asia in general, India and Nepal in particular. There are many similarities between these two countries in terms of geography, climate, agricultural operations and socio-economic contexts. However, in terms of government policies/plans, institutions and interventions relating to CSA in particular and climate change impacts in agriculture may not be similar. Thus, it is worthwhile to analyze and understand the differentiate approaches on policies/plans, practices and interventions relating to CSA in these countries. This paper further strengthens the ongoing researches and studies relating to CSA, climate change and agriculture through the integrated approach of policies/plans, practices/perceptions and people/institutions.

3 Methodology

There are numbers of researchers who have published the papers related to CSA based on their research interests and own contexts. These papers could be sources of information to assess and analyze the policies/plans, practices/perceptions and the roles of people/institutions in the implementation. Systematic review approach was adopted for this study particularly focusing on the papers published under the Science Direct (SD) and Springer link (SL) databases. This is a stepwise method to review, assess and analyze the specific papers with defined criteria. The specific inclusion and exclusion criteria were defined prior to search the papers. The details of the inclusion/exclusion criteria were presented in the Table 1. After finalization of the criteria, the first search was carried out with the keywords *"Climate-smart agriculture in South Asia, climate-smart agriculture in India and climate-smart agriculture in Nepal"* separately. Likewise, the second search was done with the keywords "*Climate-smart agricultural policies and practices in South Asia, in India and in Nepal"* separately again. We used the whole sentence in the search assuming it as the potential title of the paper. These sub-regional and country specific searches were carried out separately to analyze the country specific papers in line with the sub-regional level papers respectively. Surprisingly, the numbers of papers in India alone appeared even more than South Asian context in the first and second searches, which indicated the CSA-related country specific researches are advanced in India being a large country even more than the regional or sub-regional researches. But Nepalese cases is just opposite as very few related researches in Nepalese context. The summary of the papers selected for the assessment and analysis with the criteria is presented in Table 2. Later, the titles and abstracts of the papers were studied to exclude the review and conference papers, book chapters, short communications and editorials etc. and finalize the total number of papers for detail review and analysis. There are some papers frequently appeared (given in the parenthesis) in the search either in South Asia or India or Nepal. Furthermore, there are number of climate and agriculture related specific policies/plans, strategies and papers (either published or unpublished) in these countries, that are not included in the databases, were also reviewed separately.

Table 1 The inclusion and exclusion criteria to lessen the number of papers in the systematic search

Inclusion criteria	Exclusion criteria
• Open access journals in SD and SL. • Papers published in English. • Research papers only. • Papers published in between 2009 to 2019. • The first search with keywords "*Climate-smart agriculture in South Asia, in India and in Nepal*" separately. • The second search with keywords "*CSA policies and practices in South Asia, in India and in Nepal*" separately.	• Review papers, conference papers, book chapters, short communications, editorials were excluded. • Papers on CSA from other geographical regions except India and Nepal such as Africa, South East Asia. • Papers on energy, smart cities, sustainable urban planning and transportation, air quality, pollution and health, cotton, biofuel and plantation, oil palms etc.

Source: authors.

Table 2 The summary of the papers for detail assessment and analysis under systematic review

Name of Database	First Search	Second Search	Third Search with titles of the paper	Fourth with abstract	Total papers for review
Science Direct (SD)					
South Asia	734	482	27	20	**20**
India	948	569	26 (20)	2 (2)	(2)
Nepal	134	94	12 (8)	2 (2)	(2)
Springer Link (SL)					
South Asia	118	89	11	8	**8**
India	175	114	11 (8)	5 (4)	**1** (4)
Nepal	43	33	8 (6)	2 (2)	(2)

Note: The number in the parenthesis represent the papers overlapped in the searches (South Asia, India and Nepal) in the database.
Source: authors.

Ⅱ Results and discussion

1 CSA policies/plans

Numbers of agricultural and climate policies and plans at the national and local levels have been formulated and being implemented particularly in India and Nepal. For instance, the Government of India (GoI) implemented National Mission of Sustainable Agriculture (NMSA) in 2013, commenced National Initiative on Climate Change Resilient Agriculture (NICRA), National Adaptation Plan on Climate Change (NAPCC), National Food Security Mission (Tripathi and Mishra, 2017). The current phase of climate policy in India is pragmatic (shifted from idealism in the initial phase) with the concrete actions at the international and national level (Saryal, 2018). The NAPCC has separate national mission on sustainable agriculture and also precisely incorporated the appropriate adaptation and mitigation practices and technologies for reducing greenhouse gases and uplifting the poor and vulnerable sections of the society but it hasn't specifically mentioned anything related to CSA (GoI, 2008). Likewise, Government of Nepal (GoN) has initiated to develop number of policies/plans and frameworks and institutional mechanisms in recent decades (Mahat et al., 2019). It ratified the Kyoto Protocol in 2005, formulated National Adaptation Programme of Action (NAPA), National Climate Policy, Framework on Local Adaptation Plan of Action (LAPA) and now in the process of finalizing National Adaptation Plan (NAP), and Low Carbon Economic Development Strategy (Shrestha and Dhakal, 2019). MoE (2010) emphasized on climate-smart and robust agricultural development policies and strategies to address the current and future climate risks in NAPA document. There are limited local adaptation policies/plans and practices at the local level, though we witness some progress at the national level (Bhatta et al., 2015).

Multiple factors have been reported in the papers that are influencing these policies and plans such as identification and prioritization of the appropriate policies/plans and practices (Hochman et al., 2017b), interests and roles of the policymakers and institutions involved, resources and investments (Hochman et al., 2017b), socio-economic and cultural characteristics of farmers, bio-physical features such as locations, etc. (Khatri-Chhetri et al., 2017). These policies/plans and political engagement have also influenced in the adoption and scaling up of successful CSA practices (Westermann et al., 2018). Aryal et al. (2019) further underlined on the requirement of institutional set up and its strengthening for adoption, dissemination and scaling up of these practices and technical solutions. There are always the positive influences and sometimes counteracting policies and interests of the policymakers and political bodies especially at the local level. Westermann et al. (2018) further emphasized on appropriate institutional and governance mechanisms with enforcement of regulatory framework supported by effective participation of relevant institutions and their coordination. In Nepalese context, the institutions representing public, private and civic effectively participated and harmonized in national and local climate policies and plans.

Moreover, sectoral policies particularly agricultural and forestry policies in both countries have also support to adaptation and mitigation. These policies/plans and practices have shown the presence of both synergies (eg. creating enabling environments) and trade-off (eg. food and carbon nexus) at national level between adaptation and mitigation (Shrestha and Dhakal, 2019; Shirsath et al., 2017). The effective policies/plans guiding appropriate CSA practices lead to maximizing the synergies and minimizing the tradeoffs (Shirsath et al., 2017). The policy driven or planned, and incentivized adaptation strategies are prominent in India (Tripathi and Mishra, 2017), perhaps in Nepal as well because farmers have minimum skills and adaptive capacities to address the risks through autonomous adaptation. However, if the farmers have reliable information and better to access to the resources, they are able to deal with the impacts autonomously based on local knowledge, skills and experiences as they have been dealing with it for generations. The farmers and local communities have perceived and understood the climate and weather patterns more than any institutions. The policies/plans need to provide the information on potential CSA practices and possible sources of resources that can be accessible for efficient adoption in the specific locations (Khatri-Chhetri et al., 2017).

2 CSA practices/perceptions

Several adaptation and climate-smart practices and perceptions were portrayed in the papers that have enhance the agricultural productivity and food security, improve the climate resilience and reduce the greenhouse

Table 3 List of the papers selected for systematic review

S.N.	Source	Author(s) name	Titles of the papers and its thematic focuses	Name of the Journals
1.	SL	Aryal et al. (2015)	Impacts of laser land leveling in rice-wheat systems of the north-western Indo-Gangetic plains of India ○	Food security
2.	SL	Aryal et al. (2019)	Climate change and agriculture in South Asia: Adaptation options in smallholder production systems ◎○	Environment, Development and Sustainability
3.	SD	Bastakoti et al. (2016)	Community pond rehabilitation to deal with climate variability: A case study in Nepal Terai ○	Water Resources and Rural Development
4.	SL	Beddington et al. (2012)	The role for scientists in tackling food insecurity and climate change ◎ Δ	Agriculture and Food security
5.	SL	Bhatta et al. (2015)	Agricultural innovation and adaptation to climate change: Empirical evidence from diverse agro-ecologies in South Asia ◎○	Environment, Development and Sustainability
6.	SD	Chalise and Naranpanawa, (2016)	Climate change adaptation in agriculture: A computable general equilibrium analysis of land-use change in Nepal ◎○	Land Use Policy
7.	SD	Dunnett et al. (2018)	Multi-objective land use allocation modelling for prioritizing climate-smart agricultural interventions ○	Ecological Modelling
8.	SD	Findlater et al. (2019)	Misunderstanding conservation agriculture: Challenges in promoting, monitoring and evaluating sustainable farming ○	Environmental Science and Policy
9.	SD	Fischer et al. (2016)	Can more drought resistant crops promote more climate secure agriculture? Prospects and challenges of millet cultivation in Ananthapur, Andhra Pradesh ◎○	World Development Perspectives
10.	SL	Gangopadhyay et al. (2019)	Spatial targeting of ICT-based weather and agro-advisory services for climate risk management in agriculture ○	Climatic Change
11.	SD	Groot et al. (2019)	Business models of SMEs as a mechanism for scaling climate-smart technologies: The case of Punjab, India ○	Journal of Cleaner Production
12.	SD	Hochman et al. (2017a)	Smallholder farmers managing climate risks in India: 1. Adapting to a variable climate ○ Δ	Agricultural Systems
13.	SD	Hochman et al. (2017b)	Smallholder farmers managing climate risks in India: 2. Is it climate-smart? Δ	Agricultural Systems
14.	SD	Khatri-Chhetri et al. (2017)	Farmers' prioritization of climate-smart agriculture technologies ○	Agricultural Systems
15.	SD	Khatri-Chhetri et al. (2019)	Stakeholders prioritization of climate-smart agriculture interventions: Evaluation of a framework Δ	Agricultural Systems
16.	SD	Kumar et al. (2019)	Farm typology analysis and technology assessment: An application in an arid region of South Asia ◎○	Land Use Policy
17.	SD	Lopez-Ridaura et al. (2018)	Climate-smart agriculture, farm household typologies and food security: An ex-ante assessment from Eastern India ○	Agricultural Systems
18.	SL	Mahat et al. (2019)	Climate finance and green growth: Reconsidering climate-related institutions, investments and priorities in Nepal ◎	Environmental Sciences Europe

19.	SD	Mittal and Hariharan (2018)	Mobile-based climate services impact on farmers risk management ability in India ○	Climate Risk Management
20.	SL	Pradhan et al. (2019)	Finger millet in tribal farming systems contributes to increased availability of nutritious food at household level: Insights from India ○	Agricultural Research
21.	SD	Seidler et al. (2018)	Progress on integrating climate change adaptation and disaster risk reduction for sustainable development pathways in South Asia: Evidence from six research projects ◎	International Journal of Disaster Risk Reducation
22.	SD	Sendhil et al. (2018)	Extent of vulnerability in wheat producing agro-ecologies in India: Tracking from indicators of cross-section and multi-dimension data ◎	Ecological Indicators
23.	SD	Shirsath et al. (2017)	Prioritizing climate-smart agricultural land use options at a regional scale ◎	Agricultural Systems
24.	SD	Shrestha and Dhakal (2019)	An assessment of potential synergies and trade-offs between climate mitigation and adaptation policies in Nepal ◎	Journal of Environmental Management
25.	SL	Singh and Singh (2017)	Traditional agriculture: A climate-smart agriculture for sustainable food production ○	Engery, Ecology and Environment
26.	SD	Thornton et al. (2018)	A framework for priority-setting in climate smart agriculture research ◎	Agricultural Systems
27.	SL	Thornton et al. (2019)	Human adaptation to biodiversity change: An adaptation process approach applied to a case study from Southern India ◎○	Biodiversity Change and Human Adaptation
28.	SD	Tripathi and Mishra (2017)	Knowledge and passive adaptation to climate change: An example from Indian farmers ○	Climate Risk Management
29.	SD	Westermann et al. (2018)	Scaling up agricultural interventions: Case studies of climate-smart agriculture ◎	Agricultural Systems

Note: SD represents Science Direct, SL represents Springer Link, ◎ represents policies/plans, ○ represents practices/perceptions, and Δ represents people/institutions.
Source: authors.

gases (Table 3). CSA has these 3 specific goals of increase productivity, resilience/adaptive capacity and reduce greenhouse gases, thus, it is crucial to systematically and quantitatively assess whether adaptation practices are climate-smart or not (Hochman et al., 2017b). Whenever at least one goal of CSA is achieved, it can be considered as the CSA practice (Khatri-Chhetri et al., 2017). They further combined the agricultural and adaptation technologies, practices and services together as CSA technologies in their paper, but it is categorized as the CSA practices in this paper. The specific indicators relevant to the specific CSA goals or pillars or outcomes need to be defined in the current and future scenarios. Furthermore, the favorable policies and building adaptive capacities are pivotal for effective CSA practices (Maharjan and Maharjan, 2017). Kumar et al. (2019) emphasized on the participatory tools in consolidating the local climate complexities and prioritizing the locally appropriate CSA practices depending on local perceptions and household types.

Khatri-Chhetri et al. (2017) categorized the CSA practices into water-smart, energy-smart, nutrient-smart, carbon-smart, weather-smart and knowledge-smart to improve the use efficiency of water, energy and nutrient, reduce greenhouse gases emissions and carbon sequestration in agriculture and effective use of scientific and local knowledge. These practices were also differentiated as crop production, livestock management, soil management, water management, forestry and agroforestry, aquaculture and fisheries and energy management as entry points for CSA practices (CCAFS, 2019; Maharjan, 2019). Both categorizations have commonalities but emphasized on different aspects. These practices have potentials to fulfill the CSA goals, however not effectively managed to the full extent due to low adoption rate by the farmers in the developing world (Westermann et al., 2018). They further highlighted the prevailing issues of food insecurity and poverty in many rural areas despite the continuous efforts and innovative approaches. Singh and Singh (2017) emphasized on the agricultural or CSA practices that enhances sustainable food production to address the issues of climate change, soil degradation and biodiversity loss and also to feed the increasing population. They further highlighted the increased attention on traditional agriculture as the sustainable source of food production in the context.

Most of these agricultural or CSA practices are materialized while responding to several policy, socio-economic, institutional and natural factors over the years (Bhatta et al., 2015). The preferences and adoption choices of CSA practices are influenced by the policies/plans, socio-economic and climatic conditions including the observed risks in the areas. The adoption of these CSA practices largely relies on farmers' preferences, perceptions and willingness to invest in those practices (Khatri-Chhetri et al., 2017; Shirsath et al., 2017) and supports provided by the institutions particularly in value chains, information and communication technologies (ICT) and advisory services (Westermann et al., 2018). *'Perception is a cognitive process that involves the receiving sensory information and interpreting it'* (Tripathi and Mishra, 2017, p.2). The study conducted by Mittal and Hariharan (2018), demonstrated that ICT, particularly use of mobile phones, enhanced the adoption and implementation of CSA practices. However, there is still a huge gap between the awareness level of farmers improved and the farmers who have adopted and implemented CSA practices. Lopez-Ridaura et al. (2018) revealed the potentiality of CSA practices such as conservation agriculture in food security with the least costs and energy consumption though it is comparatively less attractive to the smallholders in India. Khatri-Chhetri (2017) emphasized the gender and social inclusion aspect and input use efficiency through the CSA practices. Some of the CSA practices such as water pond or plastic pond specifically reduce the workload of women and save time for additional income generating activities (Bastakoti et al., 2016; Gurung et al., 2016). Furthermore, these ponds provide water for agricultural productivity and fishing ultimately supporting the income and livelihood (Bastakoti et al., 2016).

The information and awareness on climate change, associated risks and CSA policies/plans and practices and their actual and potential benefits can play role in changing the perceptions. The perceptions and understanding the climate change and related risks lead to the actions to minimize the risks. The correct perceptions help to tackle the risks in positive way otherwise, the actions based on incorrect perceptions may lead to adverse impact (Tripathi and Mishra, 2017). Such information and awareness are initial steps to motivate the farmers to act on it by adopting and implementing CSA practices (Mittal and Hariharan, 2018). They further emphasized on requirement of additional resources and supports such as training and extension services, inputs and financial supports for effective adoption, implementation and scale up of CSA practices. The investments to the CSA practices also depend on the potential benefits and costs incurred for the practices (Khatri-Chhetri et al., 2017). Participatory planning and execution considering the farmers' needs might improve the adoption, but it is time consuming and needs additional resources (Westermann et al., 2018).

3 People and institutions in CSA policies/plans and practices/perceptions

The supports and additional resources have been provided by the people and institutions including public, private and civic agencies and groups. The governments and civil society groups are influential in climate related research and development in India and Nepal. These agencies have been actively involved, contributed and collaborated in the formulation and implementation of CSA policies/plans and practices. The services and supports provided by them are significant in strengthening the CSA adoption by increasing the awareness and accessibility to the relevant knowledge, skills, technologies and practices. The individual researchers and institutions have own perceptions, capacities and interests of engagement and collaborations at the local and national levels. Hochman et al. (2017b) highlighted the participatory interventions of researchers, farmers and NGOs in the climatic issues relating to rice-based farming. These people and institutions also support in identifying and prioritizing the appropriate CSA practices for better adaptability, resilience and addressing the climate variability. Likewise, Beddington et al. (2012) emphasized on the role of academic and scientific groups in conducting research, building awareness and policy recommendations on the contemporary and sustainable resource generation, wise use of resources in CSA for climate resilience, increase productivity and minimization of greenhouse gases emissions.

The climate impacts have been observed locally, thus, the responses logically need to come from the local communities and institutions, but it is often planned and guided at the higher levels with the policy and regulatory frameworks and specific responsibilities (Seidler et al., 2018). In Nepalese context, the local and community adaptation plans in the form of bottom-up planning and execution have been initiated, but the skills, capacities and confidence of the local people and institutions are not fully satisfactory. The capacities of the local people and institutions and the requirement of resources at the local level have been often the issue for bottom-up approaches, thus most often business-as-usual approaches dominate. Thus, combination of top-down (NAPA, NAP and national climate policy) and bottom-up (LAPA and CAPA) approaches would be most appropriate climate policies/plans in Nepalese and some other countries contexts including India. Some local level institutions have also applied the bottom-up planning and execution of climate and disaster risk reduction practices in India (Seidler et al., 2018). Furthermore, the study conducted by Khatri-Chhetri et al. (2019) emphasized on the gender and social inclusion specifically the role of women in CSA adoption as an important indicator.

4 Interrelationships among the CSA policies/plans, practices/perceptions and people/institutions

Climate change is an important domain in the policy arena (Tripathi and Mishra, 2017) at the local, national and international levels. Agriculture, on other hand, is the primary sector for food security and livelihood of the people in Nepal and India, which experience most of the prevailing impacts of climate change (Groot et al., 2019). Number of climate and agricultural related policies and plans have been developed and executed at the national and international levels to address the impacts and also to increase sustainable food production to ultimately fulfill the food demands of the growing population. However, it is also reported that commercial agriculture is problematic in sustainable food and energy production and also contributing to the climate change (Findlater et al., 2019; Tripathi and Mishra, 2017). Fischer et al. (2016) suggest restructuring the policy to encourage climate-smart agriculture. The triple-win goals of CSA also complement increase in food production with minimum greenhouse gases emission and enhanced adaptive capacities.

Multiple institutions and stakeholders have joint efforts to address the impacts and sustainable food production at the national and international levels. The initiatives of some of the organizations such as FAO, CCAFS in initiating and promoting CSA policies/plans and practices are promising and motivating for the governments, civil society groups and farmers to promote, adopt and implement these practices in the field levels. Farmers have multiple options and practices to sustainably increase the productivity, resilience and reduce greenhouse gases supported by several institutions and individuals including the researchers and policymakers. However, there is a huge gap in adoption and scaling up of many of these practices noticeably due to lack of extension services, access to the information, resources and technical skills and knowledge (Groot et al., 2019). CDKN (2017) further highlighted the unavailability of inputs and resources at the local market to adopt CSA practices, thus, poor farmers and smallholders are not capable to adopt, implement and scale out CSA practices at the local level. Groot et al. (2019) further emphasized that the small and medium-sized enterprises (SMEs) and their business models can be supportive in adoption and scaling up of these practices with the specific case in Punjab, India.

Also, the private institutions and business owners have also indicated the interest to invest in CSA practices in recent years. They used to be less attentive towards it as they were interested more on short-term gains (Groot et al., 2019). They further emphasized that the CSA business model needs the involvement of multiple people and institutions including the policymakers, researchers and research institutes, investors at the national and international levels. It may be necessary to develop multi-stakeholder's learning and sharing forum to develop and execute the large-scale CSA policies/plans and practices. In many instances, the existing multi-stakeholder forum at the district and national level could integrate and promote the CSA policies and plans. In this relation, Shrestha and Dhakal (2019) suggested an institution or platform to promote sufficient and operative coordination among the relevant institutions and also to explore the potential synergies and trade-offs in the CSA policies/ plans, which will be supportive to effectively implement and execute CSA practices.

The CSA pathway (Figure 2) depicts the interrelationship between the CSA institutions and the people, CSA policies/plans and CSA practices, technologies and perceptions. This is a general pathway which maybe applicable in most of the cases under the business as usual (BAU) situation. Even in the BAU, the institutions/people need appropriate investments and resources, skills and capacities for research, development, promotion and scaling up of the policies/plans and practices. Gurung et al. (2016) also followed similar pathway for scaling up of specific CSA practices in Nepal (e.g. Plastic house technology) in their report emphasizing the institutions, policy, technology and finance. In this case, the institutions (i.e., District Agriculture Development Offices) are responsible for promotion of specific practice/ technology with the specific policy of waiving of tax and subsidy on import of plastic sheets for agricultural use. The government and/or civil society organizations provide the skills and capacities through the training to the farmers on the use of plastic technology in agriculture. This specific case of plastic house technology portrays the CSA pathway in Nepal. Likewise, th GoI invested 21.8 billion USD to build 10,000 MW solar power plant to irrigate the farms at the national scale by distributing 1.75 million off-grid solar agricultural pumps (Shah, 2018). The concept of climate-smart village (CSV) has been implemented by the support of multiple institutions in both countries. Almost 500 CSVs have been launched in rice-wheat systems in Haryana, India (Cecilia, 2012). Number of policies/plans developed by the GoN including

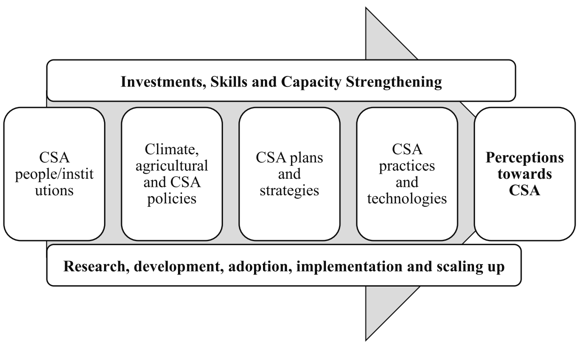

Figure 2 CSA Pathway
Source : authors.

National Adaptation Plan of Action (NAPA-2010), National Climate Policy-2011, Nepal Biodiversity Strategy and Action Plan 2014-2020 and sectoral plans have directly or indirectly supported CSV in Nepal (Adhikari et al., 2016). The institutions and people play active roles in formulating the relevant policies and plans through inclusive and interactive process, which support the effective implementation, adoption and scale up of CSA practices in cross-sectoral and interdisciplinary approach for synergies and climate resilience pathways.

Both countries are geographically, climatically, and culturally diverse, thus single CSA policy/plan and practice may not be applicable. Multiple challenges prevail in CSA concept itself, its implementation and sustainability. The foremost challenge is the conceptual clarity despite multiple institutions and researchers have redefined and utilized in different research and development interventions for almost a decade. The concept itself is defined broadly which include different agricultural practices including the simple change in cropping pattern to advanced biotechnologies (Khatri-Chhetri, 2017). Furthermore, some of the agricultural practices and technologies that have been practiced and popular among farmers prior to the CSA concept and approach such as mulching, organic farming, agroforestry, rainwater harvest etc., are also categorized as the CSA practices and approaches. Many of agriculturalists have argued on such integration of already popular practices and approaches as CSA practices/approaches.

5 Challenges

However, the report published by CDKN (2017) and Gurung et al. (2016) highlighted the lack of adequate recognition of CSA in the policies, plans and strategies, lack of documentation and extension services, and lack of scientific evidences and coordination among the institutions including the government departments and relevant organizations. They further underlined the lack of sustainability of CSA practices since most of it focused on project-based approaches, but not long-term plans. Moreover, the issue of lack of capacities among the public, civic and private sectors was also underscored in the report particularly in the Nepalese context. These contexts are also somehow relevant in Indian context.

The complexity of climate change itself is a challenge in prioritizing the CSA policies/plans and practices in any specific geography. Besides, the limited capital and resources to invest in CSA concept, policies/plans and practices are additional challenges especially in developing countries like Nepal and India (Shirsath et al., 2017). They, further, highlighted the limited studies on CSA in these countries mainly due to lack of scientific data on biophysical, climatic and production economics for detailed analysis. For instance, it is difficult to gather the reliable data on rainfall and temperature for climatic trend analysis and farmers' yields and incomes of all commodities, costs and benefits of adaptation and mitigation practices in these countries.

Moreover, the prioritization of multiple aspects of productivity, adaptation and mitigation in CSA make it more complex and challenging in its research and development (Thornton et al., 2018). It's hard that single CSA practice and approach fulfill multiple goals of the CSA. In this regard, Khatri-Chhetri et al. (2017) have clearly stated the fulfillment of at least a goal is important for CSA. It would be certainly helpful to define specific indicators with respect to the CSA goals to effectively monitor and evaluate the progresses. Khatri-Chhetri (2017) has included increase in income, increase in efficient use of inputs and gender and social inclusion as important aspects of CSA in the context of India and Nepal, which make it more complex and complicated in these countries. Thornton et al. (2018) further emphasized on uncertainty of sustainable source of funding and investment in CSA including the scale and temporal dependencies. Khatri-Chhetri et al. (2019) further revealed lack of technical knowledge, cost for investment in those technologies and the least incentives provided as additional challenges for adoption of CSA practices.

However, we believe that these complications and challenges would be minimized over the years. Khatri-Chhetri et al. (2019) revealed the increased government's investment to promote the CSA practices in India. Likewise, Government of Nepal has also emphasized on allocation of 80% of financial resources for the implementation of the local adaptation plans. The local government bodies have more power and authority in mobilization of the local financial and technical resources at present. The issues of investment and institutional supports would be increased as multiple institutions including the private sectors, cooperatives have expressed their interests in it (Groot et al., 2019). Hochman et al. (2017a) emphasized on participatory action research with farmers and relevant institutions with reliable field data and analysis to promote the CSA more practically and in a productive manner. Maharjan et al. (2017) also emphasized on assessment and analysis of local vulnerabilities, risks and adaptation practices and perceptions for location specific policies/plans and practices. It is also advisable to build the capacities and skills of local people and institutions to fully understand the CSA policies/plans and also implement, monitor and scale up the CSA practices with positive perceptions towards it.

Ⅲ Conclusions

CSA is comparatively a new concept for the improvement in agricultural system to address the emerging issues, however it has integrated some of the agricultural practices which have been taking places for decades. Since its inception in 2009, it is gaining popularity and attentions in policies/plans, practices among the policymakers, researchers and multiple institutions at all levels. Through the multiple years of its adoption, implementation and scale up, the perceptions of the farmers, researchers, policymakers and institutions towards CSA has been changed and/or in the process of changing. The developing countries such as Nepal and India have also integrated it in different possible forms either in policies/plans or in practices. However, the rate of adoption and scaling up in these countries are comparatively less because of multiple reasons including the lack of awareness, information dissemination, lack of specific CSA policies/plans, lack of investment among others. India has adopted several CSA practices throughout the country, but success rate is still not fully satisfactory. In Nepalese context, few CSA practices have gaining popularity due to the efforts of the government and civil society organizations. Some of the agricultural and climate policies/plans including the sectoral policies/plans have also integrated it.

Since it is still a new concept, further research and development including specific CSA policies/plans, enhancing skills and capacities are required for clarifying the controversies in addition to the mainstreaming it in the policies and plans at the local to national levels. The joint efforts of people and institutions at top and bottom level are important to develop and execute the CSA policies/plans and practices by changing the perceptions of the people and institutions as appropriate. The trade-off should be minimized whereas the synergies need to be enhanced in the CSA approaches and processes at all level. Both countries have many CSA practices being implemented despite minimum direct integration and reflection of CSA in the policies/plans because some of the existing agricultural practices are also included as CSA practices in both countries. The adoption and scaling up of successful CSA practices are exceptionally needed, which would be enhanced through the consolidated efforts of institutions and increased investments. The specific indicators including the aspects of gender and social inclusion is crucial in both countries. This assessment and analysis have conveyed the current contexts of the climate and agricultural policies in India and Nepal from the perspectives of the papers published in the Science Direct (SD) and Springer Link (SL) from 2009 to 2019. Further detail assessment of specific climate policies/plans and practices in these countries would be carried out in coming days.

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Ten Years of GIAHS Development in Japan

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Abstract: Approximately ten years have passed since Globally Important Agricultural Heritage Systems (GIAHS) was introduced to Japan in 2011, with 11 GIAHS sites designated so far. The Japan Nationally Important Agricultural Heritage Systems (J-NIAHS), which considers resilience, multi-stakeholder participation and sixth industrialization, was subsequently established in 2016, and has designated 15 J-NIAHS sites. GIAHS sites can be classified into three major types: Landscape, farming method, and genetic resource conservation types, and most Japanese GIAHS sites are of the landscape type. Since there is almost no national subsidy for GIAHS or J-NIAHS, designated sites are expected to secure funding for conservation from their own efforts. For this reason, a voluntary network of the Japanese GIAHS sites has been active in promoting cooperation on GIAHS conservation. The priorities of the Japanese GIAHS have focused on raising public awareness about GIAHS and J-NIAHS, improving livelihoods, as well as fostering the international exchange of experience and knowledge regarding Agricultural Heritage Systems, especially among Japan, China and Korea.

Key words: GIAHS; agricultural heritage; traditional agriculture; sustainability; biodiversity; landscape

1 Introduction

In response to the global trends in the industrialization and mass production in agriculture, as well as other social-economic changes that undermine family farming and traditional agricultural systems, the Food and Agriculture Organization of the United Nations (FAO) launched a Global Partnership Initiative on conservation and adaptive management as the “Globally Important Agricultural Heritage Systems” (GIAHS) in 2002 at the World Summit on Sustainable Development (WSSD) held in Johannesburg, South Africa (FAO, 2017).

Approximately ten years have passed since the GIAHS was introduced to Japan. It was started in 2009 with encouragement from Professor Kazuhiko Takeuchi, then Vice-Rector of United Nations University (UNU). Since the first two GIAHS designations in 2011, approximately three GIAHS sites have been designated every two years, with a total 11 GIAHS sites being designated so far in Japan. On the other hand, the Japan Nationally Important Agricultural Heritage Systems (J-NIAHS) was subsequently established in 2016, which considers the resilience, multi-stakeholder participation and sixth industrialization of potential sites, in addition to the five criteria of GIAHS. Eight sites were first designated as J-NIAHS in 2017 and another seven sites in 2019, for 15 designated J-NIAHS sites in total. In the development of GIAHS in Japan, the UNU in Tokyo has played a pivotal role in promoting understanding and interest in GIAHS (Yiu and Nagata, 2018).

This paper will trace the 10-year history of GIAHS development in Japan, and classify the types and analyze the characteristics of the Japanese GIAHS and their conservation. It will also discuss the unique voluntary GIAHS network among the GIAHS sites, policy perspectives such as support systems and subsidies from the national government, and issues related to the future development of GIAHS in Japan.

2 The development of Agricultural Heritage System designations in Japan

2.1 FAO Globally Important Agricultural Heritage Systems (GIAHS) designation in Japan

2.1.1 History of Japanese agriculture and its current situation

Cultivation of rice started approximately 3000 years ago in

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the Kyushu region in southern Japan, and from there paddy rice farming then extended to most parts of the country and laid the foundations of the Japanese agrarian societies and local economies (Kimura, 2010). Since then, agriculture has been developing along with the development of the Japanese economy and society. Especially during a period of approximately 100 years from the late 17th century, Japanese agriculture developed dramatically with the introduction of agricultural tools, fertilizer and commodity crops, and farmland expanded by land reclamation of new paddy fields. After World War II, Japanese agriculture has continued to develop further by small farmers, created by land reform, and so on. The Basic Law on Agriculture was enacted in 1961 and Japanese agriculture became modernized by introducing chemical fertilizers, chemical pesticides and agricultural machinery. While farmers' income has increased as a result, it is less lucrative than the opportunities of other rising sectors, which has caused income gaps. Moreover, rural areas have been suffering from depopulation, aging, shortage of successors, and so on. In 1999, the Basic Law on Food, Agriculture and Rural Areas replaced the Basic Law on Agriculture, and the new Law includes policies for securing a stable food supply, sustainable agricultural development, the development of rural areas and fulfillment of the multifunctional roles of agriculture and rural areas. Under these circumstances, GIAHS is recognized for its potential to contribute to revitalizing rural areas and fulfilling the multifunctional roles of agriculture and rural areas, such as conservation of national land, water resources, and the natural environment, as well as the creation of resilient landscapes and preservation of cultural traditions.

2.1.2 The beginning of GIAHS in Japan

GIAHS was mainly targeted at developing countries in its early years and drew little attention in developed countries. For this reason, very few people in Japan knew about GIAHS and interest in GIAHS was limited to individual research and activities before 2009.

In 2009, Professor Kazuhiko Takeuchi, then Vice-Rector of UNU, encouraged developed countries like Japan to explore GIAHS designations to inherit traditional agriculture systems. He suggested that Japan could apply to GIAHS based on the concept of "Satoyama", which is a traditional rural Japanese landscape where such human-influenced natural environments comprised of integrated ecosystems represent a balanced relationship between human beings and nature (Takeuchi, 2010). In 2010, Japan hosted the 10th Conference of the Parties to the Convention on Biological Diversity (CBD COP10) where many representative Satoyama in Japan were showcased to the world as case study sites of Satoyama, including the Noto Peninsula of Ishikawa Prefecture and Sado Island of Niigata Prefecture, which were subsequently designed as GIAHS. This increasing global attention from the CBD COP 10 has provided such Satoyama communities with the opportunity to rediscover their traditional agriculture systems and regain confidence in their rural way of life. The introduction of GIAHS in Japan was thus proposed under such circumstances.

The first GIAHS-themed workshop in Japan was initiated by UNU and held in June 2010 in Kanazawa City, Ishikawa Prefecture. The workshop was attended by government officials and experts from UNU, the Ministry of Agriculture, Forestry and Fisheries (MAFF), Ishikawa Prefecture, Kanazawa University, etc., including Dr. Parviz Koohafkan, then GIAHS Global Coordinator of FAO. However, at that time, interest in GIAHS by MAFF and Ishikawa Prefecture was not so obvious, and subsequent activities were stagnant. For this reason, Ms. Anne McDonald, then Director of United Nations University Institute of Advanced Studies Operating Unit Ishikawa/Kanazawa (UNU-IAS OUIK) approached the officials of the Hokuriku Regional Agricultural Administration Office (HRAAO) of MAFF, and in August 2010, an internal meeting with UNU experts was held in the Director's office of HRAAO. In the meeting, it was agreed that Noto Peninsula of Ishikawa Prefecture and Sado Island of Niigata Prefecture under the jurisdiction of HRAAO would be Japan's first GIAHS applications.

At that time, few people in the national, prefectural and municipality governments or local communities knew about GIAHS, and it was impossible to apply for GIAHS designation by a bottom-up approach, so officials from HRAAO worked with the municipal mayors and UNU coordinated with the GIAHS Secretariat of FAO. Through such activities, not only the local municipalities but also MAFF headquarters (namely the Rural Environment Division, Rural Development Bureau) and the prefectural government gradually gained understanding.

2.1.3 First designation batch in 2011

In December 2010, Sado City of Niigata Prefecture and Noto Region of Ishikawa Prefecture submitted the first GIAHS proposal to FAO with the "cooperation" of MAFF. The titles of the two GIAHS proposals were "Sado's Satoyama in Harmony with Japanese Crested Ibis" in Sado City of Niigata Prefecture, and "Noto's Satoyama and Satoumi" in the Noto Region of Ishikawa Prefecture, with "Satoyama" as the keyword for both GIAHS proposals.

The FAO GIAHS International Forum was held in June 2011 in Beijing, China to designate the new GIAHS, and the GIAHS Steering Committee meeting was held to discuss the approval of GIAHS designations at the Forum. At that meeting, Dr. Parviz Koohafkan, then GIAHS Global Coordinator of FAO, asked the participants of the meeting whether the proposed "Sado's Satoyama in Harmony with Japanese Crested Ibis" and "Noto's Satoyama Satoumi" applications of GIAHS were worth designating as GIAHS and the meeting then approved them, along with 11 other sites. These first GIAHS designations of Japan marked a monumental milestone for Japan and other developed countries as subsequent events unfolded. Although GIAHS was rarely featured in the Japanese mass media, the first GIAHS designation in Japan was widely reported in the Japanese mass media.

2.1.4 Second designation batch in 2013

Inspired by the GIAHS designations of Sado and Noto, officials from Shizuoka Prefecture, a chef of an Italian restaurant from Kumamoto Prefecture, and officials from Oita Prefecture consulted with UNU about their interest in submitting GIAHS applications. On the technical advice of UNU, the respective GIAHS promotion associations prepared the GIAHS proposals for "Traditional Tea-grass Integrated System in Shizuoka", "Managing Aso Grasslands for Sustainable Agriculture" and "Kunisaki Peninsula Usa Integrated Forestry, Agriculture and Fisheries System". At that time, MAFF requested that UNU evaluate these GIAHS proposals from an academic perspective as experts, and so UNU prepared the evaluation reports.

After submitting the proposals to FAO with the "cooperation" of MAFF, an FAO team visited the GIAHS candidate sites for the field surveys coordinated by UNU. At that time, GIAHS was operated as one of FAO's projects with Global Environment Facility (GEF) funding, but FAO did not have funding for travel expenses for field surveys in developed countries such as Japan. The FAO GIAHS Secretariat thus had to be invited to Japan under research funds provided by Japanese institutions so as to receive them for their field surveys of the GIAHS candidate sites.

In May 2013, the "GIAHS International Conference" was held in Nanao City, Ishikawa Prefecture, which was the first GIAHS International Forum held in a GIAHS site. At this Conference, every candidate site gave presentations on their GIAHS proposals, and the presentations of the three Japanese candidate sites were given by the prefectural governors. Based on the presentations, the GIAHS applications were then evaluated by the GIAHS Scientific Committee. At this Conference, the above mentioned three candidate sites in Japan were successfully designated as GIAHS, along with four other sites.

Notably, a High-level Session hosted by MAFF was held during this Conference, in which Dr. Graziano da Silva, then Director-General of FAO, also graced the event as he was in Japan to attend the 5th Tokyo International Conference on African Development (TICAD V) in Yokohama City, Kanagawa Prefecture. His participation was significant because this was the first time that the GIAHS International Conference was attended by the Secretary-General of FAO, signifying and affirming the importance of GIAHS to FAO, which subsequently accelerated developments within FAO itself to upscale the GIAHS from a project to an FAO regular programme in 2016.

2.1.5 Third designation batch in 2015

In response to growing interest in GIAHS, MAFF established the Japan GIAHS Scientific Committee in March 2014 to evaluate GIAHS proposals and monitor post-designation activities. In fact, until then, MAFF was in a position to just cooperate with the application efforts of the local governments and relied on the UNU to provide technical support for Japanese GIAHS candidate sites and evaluate the GIAHS applications at the same time. To ensure transparency and fairness in future GIAHS applications in Japan, UNU persuaded MAFF to establish an independent Japan GIAHS Scientific Committee. UNU then decided not to be involved in the evaluation of GIAHS applications in Japan, but would only provide technical support and advice on GIAHS applications to candidate sites. Since then, UNU has continued to conduct research on the conservation and utilization of GIAHS, promoting knowledge and international cooperation on GIAHS.

Since 2014, the GIAHS candidate sites have been selected through the public recruitment by MAFF, which was started in April 2014. Seven sites applied and in October 2014, MAFF announced that "Ayu of the Nagara River System", "Minabe-Tanabe Ume System" and "Takachihogo-Shiibayama Mountainous Agriculture and Forestry System" were selected as GIAHS candidate sites based on the evaluation results, including field surveys by the Japan GIAHS Scientific Committee.

In December 2015, the above-mentioned three GIAHS candidate sites in Japan were successfully designated as GIAHS along with one site from Bangladesh.

2.1.6 Fourth designation batch in 2017 and 2018

In April 2016, MAFF began public recruitment for the designation of J-NIAHS, among which several sites would be selected as GIAHS candidate sites. Nineteen sites applied, and in March 2017, MAFF decided on the designations of eight J-NIAHS sites and also on the selection of three GIAHS candidate sites based on the evaluation results, including field surveys by the Japan GIAHS/NIAHS Scientific Committee. The GIAHS candidates selected were "Osaki Kôdo's Traditional Water Management System for Sustainable Paddy Agriculture", "Traditional Wasabi Cultivation in Shizuoka" and "Nishi-Awa Steep Slope Land Agriculture System".

After being field-surveyed by members of the GIAHS Scientific Advisory Group (SAG), Osaki Region was designated as a GIAHS in December 2017, after which Wasabi Cultivation Region and Nishi-Awa Region were also designated as GIAHS in March 2018. At this point and currently, Japan has a total of 11 GIAHS sites, second to just China with 15 GIAHS sites (Table 1).

2.1.7 Applications for the 5th designation batch

In January 2018, MAFF began a public recruitment regarding approval of GIAHS applications to FAO and designation of J-NIAHS. Twenty sites applied, and in February 2019, MAFF decided on the designation of seven J-NIAHS sites and also on the selection of three GIAHS candidate sites to submit applications to FAO based on the evaluation results,

Table 1 GIAHS designation in Japan

Title of GIAHS	Region	Prefecture	Year of designation
Sado's Satoyama in Harmony with Japanese Crested Ibis	Sado	Niigata	2011
Noto's Satoyama Satoumi	Noto	Ishikawa	2011
Traditional Tea-grass Integrated System in Shizuoka	Kakegawa	Shizuoka	2013
Managing Aso Grasslands for Sustainable Agriculture	Aso	Kumamoto	2013
Kunisaki Peninsula Usa Integrated Forestry, Agriculture and Fisheries System	Kunisaki Peninsula Usa	Oita	2013
Ayu of the Nagara River System	Nagara River	Gifu	2015
Minabe-Tanabe Ume System	Minabe-Tanabe	Wakayama	2015
Takachihogo-Shiibayama Mountainous Agriculture and Forestry System	Takachihogo-Shiibayama	Miyazaki	2015
Osaki Kôdo's Traditional Water Management System for Sustainable Paddy Agriculture	Osaki	Miyagi	2017
Traditional Wasabi Cultivation in Shizuoka	Wasabi Cultivation Region	Shizuoka	2018
Nishi-Awa Steep Slope Land Agriculture System	Nishi-Awa	Tokushima	2018

including field surveys by Japan GIAHS/NIAHS Scientific Committee. The GIAHS applications to FAO were approved for "Fruit Cultivation System in Kyoutou Region" (later changed to "The Alluvial Fan Fruit Cultivation System of the Kyoutou Region"), "Biwa Lake to Land Integrated System" and "Integrated Tajima Beef Production System". These sites submitted GIAHS proposals to FAO in October 2019 which are currently being evaluated by the SAG of FAO.

2.2 Japanese Important Agricultural Heritage Systems (J-NIAHS)

2.2.1 Establishment of Japanese agricultural heritage

In April 2016, MAFF established the Japanese Important Agricultural Heritage Systems (J-NIAHS). J-NIAHS is a scheme in which MAFF designates agricultural systems that practice important and traditional agriculture, forestry and fisheries in Japan. The designation criteria for J-NIAHS include the five criteria of GIAHS and three original Japanese criteria: resilience to change, the participation of various actors and promotion of sixth industrialization. These three additional designation criteria are based on the results of a study entitled "Developing Comprehensive Assessment Method for Ingenious 'Agri-Cultural' Systems in Japan" (ACS) entrusted by the Policy Research Institute of MAFF that was jointly conducted by UNU and the University of Tokyo.

Regarding resilience to change, in Japan where there are frequent natural disasters, many agriculture, forestry and fisheries systems have repeatedly endured the impacts of natural disasters and responded to changes over their long history. To conserve agriculture, forestry and fisheries systems and pass them on to the next generation, it is important to maintain high resilience towards disasters, ecological changes, etc.

Regarding the participation of various actors, coping with the aging population, depopulation and social changes is important to maintain and revitalize the agriculture, forestry and fisheries systems. The inheritance and conservation of such Agricultural Heritage Systems should not be the responsibility of the local residents, but they should be achieved through a new co-management system with the participation of various actors from within the community as well as external actors.

Regarding the promotion of sixth industrialization—the local integration of agricultural production as primary industry, processing as secondary industry and marketing as tertiary industry—it is vital to utilize the historical value of agriculture, forestry and fisheries systems, their products, traditional cultures, landscapes and seascapes, etc. Promoting the sixth industrialization of the GIAHS will entail finding new, innovative ways of marketing and business models, such as branding of agricultural products and promotion of tourism, to revitalize and conserve the agriculture, forestry and fisheries systems (MAFF, 2020).

2.2.2 First designation batch in 2017

Following the public recruitment in April 2016, MAFF announced the selected GIAHS candidate sites and designated eight J-NIAHS sites based on their evaluation by Japan GIAHS/NIAHS Scientific Committee in March 2017 (Table 2).

Among these eight designated J-NIAHS sites, three sites (Osaki Region, Wasabi Cultivation Region and Nishi Awa Region) were later designated as GIAHS in 2017 and 2018, and another site (Kyoutou Region) was selected as a candidate site for GIAHS designation.

2.2.3 Second designation batch in 2019

Following the public recruitment in January 2018, MAFF announced the designation of seven J-NIAHS sites in February 2019 (Table 3). Among these seven J-NIAHS sites, two sites (Lake Biwa Region and Hyogo Mikata Region) later applied for GIAHS designation. The number of J-NIAHS sites grew to 15 in total.

2.2.4 Recruitment of the third designation batch

From January to July 2020, MAFF conducted a public recruitment for GIAHS candidate sites and the designation of

Table 2 J-NIAHS designated sites (First batch in March 2017)

Title of J-NIAHS	Region	Prefecture	Year of GIAHS designation
Paddy agriculture system with ingenious water management in Osaki Kodo	Osaki	Miyagi	2017
Fallen leaf compost farming system in Musashino	Musashino	Saitama	–
Integrated fruit tree system in Yamanashi adapted to the basin	Kyoutou	Yamanashi	Still candidate
Traditional Wasabi Cultivation in Shizuoka	Wasabi	Shizuoka	2018
Rice farming and carp raising system utilizing blessings of snow	Chuetsu	Niigata	–
Toba-Shima Ama fishery and pearl culture-Satoumi system for sustainable fishery	Toba-Ise-Shima	Mie	–
Owase cypress forestry produced by steep terrain and Japan's leading heavy rainfall	Owase-Kihoku	Mie	–
Steep slope land agriculture system in Nishi-Awa	Nishi-Awa	Tokushima	2018

Note: "–" means the system is only J-NIAHS, and it is not GIAHS candidate.

Table 3 J-NIAHS designated sites (Second batch in February 2019)

Title of J-NIAHS	Region	Prefecture	Year of GIAHS designation
Yamagata's "Best Safflower" connecting History and Tradition —The only Japanese processing system for safflower production and dyeing which is rare in the world	Mogami River Basin	Yamagata	–
Brackish Water Lake Fishery System of Mikata Goko Lake	Mikata Goko	Fukui	–
Biwako System interwoven with Fishery and Agriculture nurtured in Forest, Village and Lake (Umi)	Lake Biwa	Shiga	Still candidate
Hyogo Mikata's Tajima Cattle System	Hyogo Mikata	Hyogo	Still candidate
Shimotsu Warehouse Storage Mandarin System	Shimotsu Region of Kainan City	Wakayama	–
Resource Circulation Agriculture of Okuizumo derived from Tatara Ironmaking	Okuizumo	Shimane	–
Citrus Farming System of Ehime-Nanyo	Nan-yo	Ehime	–

Note: "–" means the system is only J-NIAHS, and it is not GIAHS candidate.

J-NIAHS. Thirteen sites applied, and in September 2020, it was announced that 12 sites passed the first screening. Field surveys were conducted from October to December 2020, the second screening is scheduled to be held with presentations by the candidate sites in January 2021, and the final results will be announced around February 2021.

3 Characteristics of Japanese Agricultural Heritage Systems and their conservation

Since Japanese agricultural heritage systems are based on the "Satoyama" concept, which is a traditional rural Japanese landscape where such a human-influenced natural environment comprised of integrated ecosystems represents a balanced relationship between human beings and nature (Takeuchi, 2010) as mentioned above, Japanese GIAHS have been emphasizing the landscape aspect.

At the same time, since Japan is one of the developed countries, its agricultural policy for the conservation of GIAHS is not same as those of the developing countries, especially in terms of the initiative of local governments and local stakeholders.

In this section, the characteristics of Japanese GIAHS are clarified from the perspectives of GIAHS typology and agricultural policy.

3.1 GIAHS typology

Since a proposed GIAHS site is assessed based on the five key criteria and an action plan stipulated by FAO, every GIAHS site should fulfill at least all five of these criteria. However, the way to meet these five criteria is different in each site according to its characteristics. Some GIAHS sites focus more on the landscape aspect while others focus more on traditional knowledge, such as the farming methods for specific crops. Therefore, we found that the current 62 worldwide designations of GIAHS can be classified into three types: 1) landscape type; 2) farming method type; and 3) genetic resource conservation type.

The landscape type is an Agricultural Heritage System centered on a landscape like "Satoyama", that is a regional unit that develops activities of agriculture, forestry and fisheries on the land. The components of the landscape, such as farmland, hinter forest, river, irrigation canal/pond and human settlements, are closely interlinked and interconnected. It could also include watershed areas that are considered essential for the farming environment and agro-ecology.

The farming method type focuses on a specific traditional farming method that is unique to the traditional agricultural system and effective for the conservation of biodiversity. It is relatively easy to identify the farmland on which the specific traditional farming method is practiced.

The genetic resource conservation type is where globally important genetic resources are conserved through the continual practice of the traditional agricultural system.

According to this typology, we proposed a classification of the 62 current GIAHS designated by FAO, including the Japanese GIAHS sites (Table 4). More than half of the

Table 4 GIAHS Typology

FAO region (No. of sites)	Country/Site (No. of sites)	Name of system and year designated	Classification of type of system
Africa (3)	Kenya (1)	1. Oldonyonokie/Olkeri Maasai Pastoralist Heritage (2011)	Farming method
	Tanzania (2)	2. Engaresero Maasai Pastoralist Heritage Area (2011)	Farming method
		3. Shimbue Juu Kihamba Agroforestry Heritage Site (2011)	Landscape
Asia and the Pacific (40)	Bangladesh (1)	4. Floating Garden Agricultural Practices (2015)	Farming method
	China (15)	5. Rice Fish Culture (2005)	Farming method
		6. Wannian Traditional Rice Culture (2010)	Genetic resource
		7. Hani Rice Terraces (2010)	Landscape
		8. Dong's Rice Fish Duck System (2011)	Farming method
		9. Pu'er Traditional Tea Agrosystem (2012)	Farming method
		10. Aohan Dryland Farming System (2012)	Landscape
		11. Kuajishan Ancient Chinese Torreya (2013)	Genetic resource
		12. Urban Agricultural Heritage—Xuanhua Grape Garden (2013)	Farming method
		13. Jiaxian Traditional Chinese Date Gardens (2014)	Genetic resource
		14. Xinghua Duotian Agrosystem (2014)	Farming method
		15. Fuzhou Jasmine and Tea Culture System (2014)	Farming method
		16. Huzhou Mulberry-dyke and Fish Pond System (2017)	Farming method
		17. Diebu Zhagana Agriculture-Forestry-Animal Husbandry Composite System (2017)	Landscape
		18. Xiajin Yellow River Old Course Ancient Mulberry Grove System (2018)	Genetic resource
		19. Rice Terraces in Southern Mountainous and Hilly areas (2018)	Landscape
	India (2)	20. Koraput Traditional Agriculture (2012)	Landscape
		21. Kuttanad Below Sea Level Farming System (2013)	Landscape
	Islamic Republic of Iran (3)	22. Qanat Irrigated Agricultural Heritage Systems, Kashan (2014)	Landscape
		23. Qanat-based Saffron Farming System in Gonabad (2018)	Genetic resource
		24. Grape Production System in Jowzan Valley (2018)	Landscape
	Japan (11)	25. Noto's Satoyama and Satoumi (2011)	Landscape
		26. Sado's Satoyama in Harmony with Japanese Crested Ibis (2011)	Landscape
		27. Managing Aso Grasslands for Sustainable Agriculture (2013)	Landscape
		28. Traditional Tea-grass Integrated System in Shizuoka (2013)	Farming method
		29. Kunisaki Peninsula Usa Integrated Forestry, Agriculture and Fisheries System (2013)	Landscape
		30. Ayu of the Nagara River System (2015)	Landscape
		31. Minabe-Tanabe Ume System (2015)	Landscape
		32. Takachihogo-Shiibayama Mountainous Agriculture and Forestry System (2015)	Landscape
		33. Osaki Kôdo's Traditional Water Management System for Sustainable Paddy Agriculture (2017)	Landscape
		34. Nishi-Awa Steep Slope Land Agriculture System (2018)	Farming method
		35. Traditional Wasabi Cultivation in Shizuoka (2018)	Farming method
	Philippines (1)	36. Ifugao Rice Terraces (2011)	Landscape
	Republic of Korea (5)	37. Traditional Gudeuljang Irrigated Rice Terraces in Cheongsando (2014)	Landscape
		38. Jeju Batdam Agricultural System (2014)	Landscape
		39. Traditional Hadong Tea Agrosystem in Hwagae-myeon (2017)	Farming method
		40. Geumsan Traditional Ginseng Agricultural System (2018)	Farming method
		41. Damyang Bamboo Field Agriculture System (2020)	Landscape
	Sri Lanka (1)	42. Cascaded Tank-Village System in the Dry Zone (2018)	Landscape
	Kashmir (1)	43. Saffron Heritage of Kashmir (2011)	Genetic resource

(*To be continued on the next page*)

(*Continued*)

FAO Region (No. of sites)	Country/Site (No. of sites)	Name of system and year designated	Clasification of type of system
Europe and Central Asia (7)	Italy (2)	44.Olive Groves of the Slopes between Assisi and Spoleto (2018)	Landscape
		45. Soave Traditional Vineyards (2018)	Landscape
	Portugal (1)	46. Barroso Agro-Sylvo-Pastoral System (2018)	Landscape
	Spain (4)	47. The Agricultural System of Valle Salado de Añana (2017)	Farming method
		48. Malaga Raisin Production System in La Axarquía (2017)	Landscape
		49. The Agricultural System Ancient Olive Trees Territorio Sénia (2018)	Genetic resource
		50. Historical Irrigation System at l'Horta de València (2019)	Landscape
Latin America and the Caribbean (4)	Brazil (1)	51. Traditional Agricultural System in the Southern Espinhaço Range, Minas Gerais (2020)	Landscape
	Chile (1)	52. Chiloé Agriculture (2011)	Genetic resource
	Mexico (1)	53. Chinampa System in Mexico (2018)	Farming method
	Peru (1)	54. Andean Agriculture (2011)	Genetic resources
Near East and North Africa (8)	Algeria (1)	55. Ghout Oasis System El Oued (2011)	Landscape
	Egypt (1)	56. Dates production System in Siwa Oasis (2016)	Genetic resource
	Morocco (2)	57. Oases System in Atlas Mountains (Oases of the Maghreb) (2011)	Landscape
		58. Argan-based Agro-Sylvo-Pastoral System within the area of Ait Souab-Ait and Mansour (2018)	Genetic resource
	Tunisia (3)	59. Gafsa Oases (Oases of the Maghreb) (2011)	Landscape
		60. Hanging Gardens from Djebba El Olia (2020)	Landscape
		61. Ramli Agricultural System in the lagoons of Ghar El Melh (2020)	Landscape
	United Arab Emirates (1)	62. Al Ain and Liwa Historical Date Palm Oases (2015)	Genetic resource

Note: The FAO region, order and classification of GIAHS country/site are based on the FAO GIAHS website: http://www.fao.org/giahs/en/.

GIAHS are the landscape type with 33 sites (53%), followed by 17 sites (28%) of the farming method type and 12 sites (19%) of the genetic resource conservation type. Some of these GIAHS are also located in urban or sub-urban areas, such as Xuanhua Grape Garden of China and Ayu of the Nagara River System of Japan, which indicates that traditional agricultural systems are not necessarily limited to the rural context.

From this typology, it is found that the majority of Japanese GIAHS could be classified as the landscape type (8 sites or 73%), with the remaining sites placing more emphasis on their farming method (3 sites or 27%), while none of the sites had prominent genetic resources. This could be because Japanese GIAHS are often build upon the "Satoyama" concept and the GIAHS site areas also include watershed areas, hinter forests and grasslands which may not be agriculturally productive land per se but are nonetheless important components to the holistic functioning of the rural environment (Reyes et al., 2020). The landscape type GIAHS focuses not only on agricultural farmlands, such as paddy fields and upland fields, but also emphasizes a certain extent of ecological cohesion of the surrounding environments, including hinter forests, rivers and other watershed connections. The landscape type GIAHS that have been designated around the world so far have also acknowledged that these landscapes are maintained by the local community and their culture, including even non-farmer residents. Moreover, from the aspects of agroecology and biodiversity conservation, a broader and more encompassing inclusion of diversity at the ecosystem level is also essential, rather than dealing only with the farming ecosystems in isolation. It is this understanding of the importance that the rural environment must be an integrated, holistic landscape that explains why more than half of the GIAHS designated around the world at this point are of the landscape type. However, the recent FAO requirements seem to overemphasize the mapping and boundaries of sites that include only the directly related farmlands, as set out in "Guidelines for making GIAHS Proposal Document" (FAO, 2020). This narrow perception of the complexity and connectivity of the GIAHS landscape with its surrounding environments may lead to the risk of an incomplete understanding of the GIAHS and restrict future conservation activities to only a small portion of the total GIAHS area.

One-quarter of Japanese GIAHS still maintain prominent traditional farming methods despite fierce competition in the highly modernized and mechanized agriculture in Japan, suggesting that such methods are truly time-tested and sustainable practices. However, while most Japanese GIAHS also have traditional crops and local livestock species, such genetic resources have not been emphasized very much. Future conservation efforts could consider making an inventory or record of the genetic resources of the Japanese GIAHS for more effective conservation.

3.2 Government support for GIAHS sites

In Japan, although there are many national subsidies available to and commonly used in rural farming areas that could include GIAHS sites, there are no direct subsidies from the national government that target GIAHS sites exclusively (Yiu et al., 2016). In other words, the municipalities or communities of Japanese GIAHS do not receive direct funding or subsidies for their GIAHS designation from the national government either upon or after GIAHS designation. Therefore, applicants to GIAHS are expected to have their own financial and funding capacities to ensure and prove the sustainability of the GIAHS after designation, rather than relying on national subsidies. GIAHS conservation activities are then based on self-help efforts, depending on how individual GIAHS sites intend to make the best of their designation through marketing efforts or fund pooling from interest holders, or other means.

There are many GIAHS conservation activities implemented by local governments and local stakeholders in Japan, such as tourism, branding, eco-payments, and education. For example, in Sado GIAHS region, the residents of the small settlement themselves take on the role of guides for the rice terraces. In Noto GIAHS region, elderly farmers run a farmers' inn and approximately 50 farm households receive more than 10000 guests every year. Regarding branding, almost all GIAHS sites have their own GIAHS logos and use them effectively for marketing their products. Some GIAHS sites have their own certification schemes for their products as a kind of eco-payment. For example, in Shizuoka GIAHS region, "Tea produced by GIAHS Traditional Tea-grass Integrated System practitioner" is displayed on tea products according to the certified effort and contribution towards maintenance of the tea-grassland which conserves biodiversity. In Oita GIAHS region, learning GIAHS in the schools is implemented by using animation in elementary schools, "delivery class" in junior high schools and interviews with senior farmers in senior high schools.

To attain economic sustainability and secure livelihoods, Japanese GIAHS emphasizes raising the awareness of GIAHS, attracting tourists to GIAHS sites, and other marketing efforts to add value and to be able to sell GIAHS agricultural products at higher prices. Although the national government, that is MAFF, do not give direct subsidies, the Ministry contributes to the efforts on raising awareness of GIAHS, such as holding events and media outreach. On the national policy basis, GIAHS has also been stipulated as a policy mechanism in the Basic Plan on Food, Agriculture and Rural Areas, which has been decided by the Cabinet since 2015 and is reassessed every five years based on the Basic Law on Food, Agriculture and Rural Areas.

3.3 Voluntary GIAHS network by GIAHS sites

In many countries, the state convenes national meetings of the GIAHS sites, whereas Japanese GIAHS sites form voluntary nationwide networks without direct national government involvement. These networks include the "Inter-prefectural Committee for GIAHS partnership" comprised of the prefectural governments and the "J-GIAHS Network" formed by the municipality governments. The related meetings, workshops and joint events have been organized jointly and voluntarily, with a prefecture or municipal government taking the annual chairmanship of each respective network on a rotating basis. However, these two networks were integrated in December 2020 to avoid the duplication of efforts. The new network consists of prefectures, municipalities and organizations such as GIAHS Promotion Associations in GIAHS sites, with MAFF, UNU, FAO Liaison Office in Japan, and others participating as advisors and observers. Their activities include improving the quality of efforts such as utilizing and conserving GIAHS, raising awareness of GIAHS, sharing and disseminating international information and contributions, establishing a unified domestic structure, and holding workshops. J-NIAHS sites are not included in this network, but they are invited to the events such as workshops.

4 Challenges and future opportunities

In the ten years since the first designation, Japanese GIAHS have each and collectively faced many challenges. Nonetheless, these challenges are often revealed as opportunities. The challenges and opportunities in the future development of GIAHS will include the following.

4.1 Further raising the awareness of GIAHS

As mentioned above, to ensure the sustainable conservation of GIAHS, GIAHS communities must be able to increase their income by effectively utilizing their GIAHS designation. In many countries, GIAHS are protected from the pressures of urban development. However, in the case of Japan, GIAHS must be protected from other pressures as well, such as the challenges caused by depopulation due to the aging of the local population, lack of successors, abandonment of farmland, and wildlife damages. For that purpose, GIAHS designation must be utilized to increase the number of tourists and add value to the agricultural products sold at the site. This will only be largely effective with increased awareness of GIAHS. Unfortunately, even after ten years, the recognition of GIAHS in Japan is still not high. The national and local governments are also making efforts to raise awareness of GIAHS by using various outreach tools such as promotion events, websites, symposia and workshops. Still, it is necessary to strengthen such activities further to raise the awareness of people through more creative means and reach a wider audience.

4.2 Inheritance of GIAHS by the younger generation

The population of rural Japan, including GIAHS sites, is aging. On the other hand, GIAHS designation brings confidence and pride to the younger generation in the GIAHS sites. In GIAHS sites, in order to pass on GIAHS to the younger generation, the education on GIAHS is customized according to the educational stages: Elementary school, junior high school, and high school. MAFF also holds events related to GIAHS research for high school students. Education on GIAHS for the younger generation can be carried out at a relatively low cost with the understanding and cooperation of the stakeholders concerned. In the future, it will be necessary to strongly educate and promote passing on GIAHS to the younger generation, who will be responsible for and support GIAHS in the future.

4.3 Monitoring and evaluation of GIAHS

Effective monitoring and evaluation are essential to take stock of progress, introduce timely interventions and motivate stakeholders with the results of their efforts. In Japan, each GIAHS site is responsible for the monitoring of GIAHS conservation activities, often based on a five-year Action Plan. In the last year of the Action Plan, or based on the activities of the previous fiscal year, MAFF will conduct monitoring and evaluation of the respective GIAHS whereby the Japan GIAHS/NIAHS Scientific Committee will evaluate the self-assessment reports submitted by the GIAHS sites. The Action Plan should include indicators and targets, in quantitative terms as much as possible, and specify who should and how to conduct monitoring and evaluation. However, there are no concrete standards required of the GIAHS sites, so this system lacks uniformity and equality, as some may report less while others may report more since they are free to decide on their own reporting scope. However, studies have shown that there are some common characteristics and indicators which can be taken into consideration to enhance and enforce the monitoring and evaluation efforts in Japan (Kohsaka and Matsuoka, 2015; Reyes et al., 2020). Thus, Japan could improve the monitoring and evaluation methodologies to ensure greater effectiveness and uniformity of the exercise. The Japanese GIAHS should also view the monitoring and evaluation process positively, as an opportunity to improve their actions and report the outcomes to the public in order to generate greater interest and awareness.

4.4 Promotion of international cooperation on GIAHS

Since GIAHS sites have been designated as globally important, it is necessary for them to connect with the world. In October 2013, China, Japan and South Korea agreed to the Chinese proposal to establish the East Asia Research Association for Agricultural Heritage Systems (ERAHS). The ERAHS Conference has been organized every year since 2014, except for 2020, with the three countries rotating as the host country. Six ERAHS conferences have been held so far, and most of the Japanese GIAHS sites have actively participated every year. In addition, based on the concept of "twinning of GIAHS" as endorsed by the Noto Communique of the 2013 GIAHS International Conference, some GIAHS sites are actively engaged in exchanges with overseas GIAHS sites, which include training and capacity building activities for the GIAHS in developing nations. GIAHS sites could also tap into their sister cities network, and promote interest and understanding of GIAHS, regardless of whether their counterparts are located in developing or developed countries, as Japan can be a role model to both. It is necessary for the Japanese GIAHS to continue to promote international cooperation in order to generate global interest and support for GIAHS, which will help them maintain and utilize their own GIAHS.

Reflecting on the ten years of GIAHS designations in Japan, while much still awaits improvements to enhance the effectiveness of conservation, the GIAHS designation has stimulated policy interventions and academic research. Local policy schemes are introduced to promote multiple stakeholder conservation efforts (Qiu et al., 2014), fund pooling (Yiu, 2014), product certification (Kajima et al., 2017), and agro-tourism (Chen et al., 2018), etc., as well as increasing research related to biodiversity status (Hayashi, 2014; Inagaki and Kusumoto, 2014), non-market food production and consumption patterns (Kamiyama et al., 2016), cultural features (Kajihara et al., 2018) and landscape connectivity (Hara et al., 2018), etc. within the GIAHS sites. Such GIAHS activities have not only snowballed interest from outside, but they have also reframed the sense of pride among the local people amidst the dim realities of the increasingly depopulated and aged rural communities of Japan. Henceforth, GIAHS designations in Japan have been meaningful and are necessary, as Professor Takeuchi, who introduced GIAHS to Japan, stressed "*we cannot restore traditional agriculture, forestry and fishery systems passed down to us from our ancestors once they are lost. It is imperative for us to transfer such invaluable agriculture, forestry and fishery systems to the next generations, including through the cooperation of various actors to add further value to agricultural, forestry and fishery products with GIAHS designation*" (Yiu and Nagata, 2018). GIAHS designations in Japan have inspired the awakening of its people from all walks of life in coming together as one to inherit their agricultural heritage, through rediscovering their cultural values and pride and rethinking about sustainable production and harmonious living with nature.

5 Conclusions

The designations of GIAHS in Japan and their subsequent development have shown that GIAHS need not be restricted to developing countries, but it is indeed also applicable for developed nations. Following Japan's designations, other developed countries also began to show interest and were successful in their applications, such as several countries in Europe like Spain, Portugal and Italy. Japan's first GIAHS designations in 2011 will always be a key milestone in

GIAHS history, but will not be the end of the Japanese GIAHS story. With a nationwide campaign to promote the achievement of the United Nations Sustainable Development Goals (SDGs) under the Japanese Cabinet Office, Japanese GIAHS are in a good position to synergize their GIAHS conservation efforts with the SDGs, thereby contributing not only to local rural revitalization but also to finding local solutions to address global challenges. Moreover, GIAHS sites have a great deal of relevance and potential to contribute to several of the UN decades—Family Farming 2019–2028, Ecosystem Restoration 2021–2030, and Ocean Science for Sustainable Development 2021–2030—Through showcasing how a harmonious relationship can be built between people and nature. In particular, in the post-COVID-19 pandemic world when societies will start to reconcile their soured relationship with nature, GIAHS can provide invaluable lessons and knowledge on how to build back better a healthier planet for all. Japanese GIAHS can contribute by leading as an example of how GIAHS conservation can contribute to global goals and sustainable development.

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Leveraging Japanese Sado Island Farmers' GIAHS Inclusivity by Understanding Their Perceived Involvement

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Abstract: Sado Island in the Niigata prefecture is among the first Globally Important Agriculture Heritage Systems (GIAHSs) in Japan and among developed countries worldwide. Recent studies have pointed out the need to incorporate culture and farmer opinions to further strengthen GIAHS inclusivity in rural farming. In connection to this, this study explored whether farmer visibility, which is highlighted by GIAHS designation, actually translates to farmers' actual perceptions of GIAHS involvement. A survey was conducted among Sado Island farmers to determine their knowledge and perception of their GIAHS involvement, in connection to their perspectives on youth involvement, Sado Island branding, and tourism management. Results showed that 56.3% of Sado Island farmers feel uninvolved or unsure towards the GIAHS, which is in stark contrast with the prevalent farming method in the area, special farming (which complies with GIAHS regulations) (77.3%). Further analyses revealed that farmers who feel that the GIAHS does not promote youth involvement, Sado Island branding, and tourism management have a higher predisposition to perceive themselves as uninvolved towards the GIAHS. This study highlights the need for careful reevaluation and integration of farmer insights and needs into the current GIAHS implementation in Sado Island and in other GIAHSs as well.

Keywords: GIAHS; farmer involvement; youth inclusivity; tourism management; Tokimai branding

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1. Introduction

In 2002, the Food and Agriculture Organization of the United Nations (FAO) first launched the Globally Important Agriculture Heritage System (GIAHS) Program during the World Summit on Sustainable Development in Johannesburg, South Africa. This is part of the Global Partnership Initiative which aims to tackle issues such as sustainable development, agriculture, and traditional farming practices [1]. In 2015, it became a corporate program of the FAO which was further developed to protect traditional agricultural systems of global importance and enhance the harmonious relationship between people and nature. Specifically, the FAO defines the GIAHS in 2002 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" [2] (p. 1). The selection criteria to be designated as a GIAHS are: (1) food and livelihood security; (2) agrobiodiversity; (3) traditional knowledge; (4) cultures and social values; and (5) landscape features. Overall, the object of designation is an agricultural system composed of traditional knowledge and practices, landscapes, culture, and biodiversity [3]. Since 2005, the FAO has designated 62 systems in 22 countries and is currently reviewing 15 proposals from eight new countries. These selected sites worldwide provide food and livelihood security for millions of small-scale farmers, as well as sustainably produced goods and services. Furthermore, they contribute to the

2030 Agenda for Sustainable Development by bringing together economic, social, and environmental dimensions [1].

The overall objective of designating a GIAHS site is to highlight unique knowledge, practices, and landscapes, as well as supporting dynamic conservation of a site. The conservation of GIAHS sites is also highly advocated, entailing several developmental interventions, such as agritourism activities, adding value to GIAHS food products, technology transfer measures, awareness-raising campaigns, and supportive national policies [3]. It is important to note that designating different sites as GIAHSs can also increase awareness and visibility for farmers who are working in these areas and emphasize the critical role they play in global issues. According to the FAO, the backbone of many GIAHS sites are the small-scale and family farmers, since they contribute to achieving food security, preserving rural knowledge, and protecting agrobiodiversity and fragile landscapes [1]. Therefore, raising farmer visibility is essential, most especially in this modern era when the field of agriculture faces a range of issues, including the declining interest of youths, outmigration from rural to urban areas, farmland abandonment, the transfer of indigenous and traditional knowledge, the prioritization of modernization movements in conflict with agricultural land decline and environmental degradation, among others [4–8]. Improving the image of agriculture can help address these issues, such as highlighting farmer visibility in traditional agricultural systems, which in turn can boost the status of agriculture worldwide. While increasing farmer visibility is important, it is also crucial to know if the importance of GIAHS principles actually translates to the ground level, particularly the farmers' perceptions on their GIAHS involvement. This paper will focus on this aspect by analyzing Japanese farmers' GIAHS inclusivity and how this may affect the GIAHS development in Sado Island. In particular, this paper aims to answer the question: Does farmer visibility, which is highlighted by the GIAHS designation, translate to farmers' actual perceptions of GIAHS involvement?

Globally Important Agricultural Heritage Systems (GIAHSs) in Japan and Their Impact on Farmer Involvement

In Japan, sustainable agriculture has been promoted for several years and high importance is given in preserving traditional farming, agro-culture, and biodiversity. This led to the application and acceptance of different sites in Japan as a GIAHS. Aside from the FAO's initial five selection criteria, Japan added three additional criteria in 2015 to have a more holistic and comprehensive assessment of the GIAHS, which are: (1) enhancing resilience (ecological); (2) establishing the participation of multiple stakeholders and promoting institutions (social); and (3) creating new business models (economic) [9]. At present, there are 11 sites designated as a GIAHS in Japan (Figure 1) [10]. All these sites have demonstrated remarkable use of land systems and landscapes, a good interplay between nature and its surrounding communities, and rich biological diversities, which all contribute to sustainable development. This paper is particularly focused on Sado Island in the Niigata prefecture, which is one of the first GIAHS sites designated in not only in Japan, but also in a developed country.

GIAHS sites are categorized into three major types, namely: landscape, farming method, and genetic resource conservation, of which a majority of Japanese GIAHS sites are classified as landscape types (Table 1) [11]. Out of the 11 GIAHS sites in Japan, eight, including Sado Island are classified as landscape types. Landscape type GIAHS sites comprise 33 of the 62 sites worldwide. This type of GIAHS focuses more on the interconnectedness of various landscape components, such as farmlands, rivers, irrigation canals/ponds, human settlements, among others. In Japan, this is similar to the Satoyama and Satoumi mosaic landscapes, which establish ecosystem services in connection with human well-being [12]. The three remaining GIAHS sites in Japan have a farming method classification system. There are 17 of these in the world, and they focus on the unique, traditional agricultural systems which are effective in biodiversity conservation [11]. The last one is the genetic resource conservation type, whereby traditional agricultural systems contribute to the conservation of genetic resources. There are 12 such GIAHSs in the world, but none in Japan.

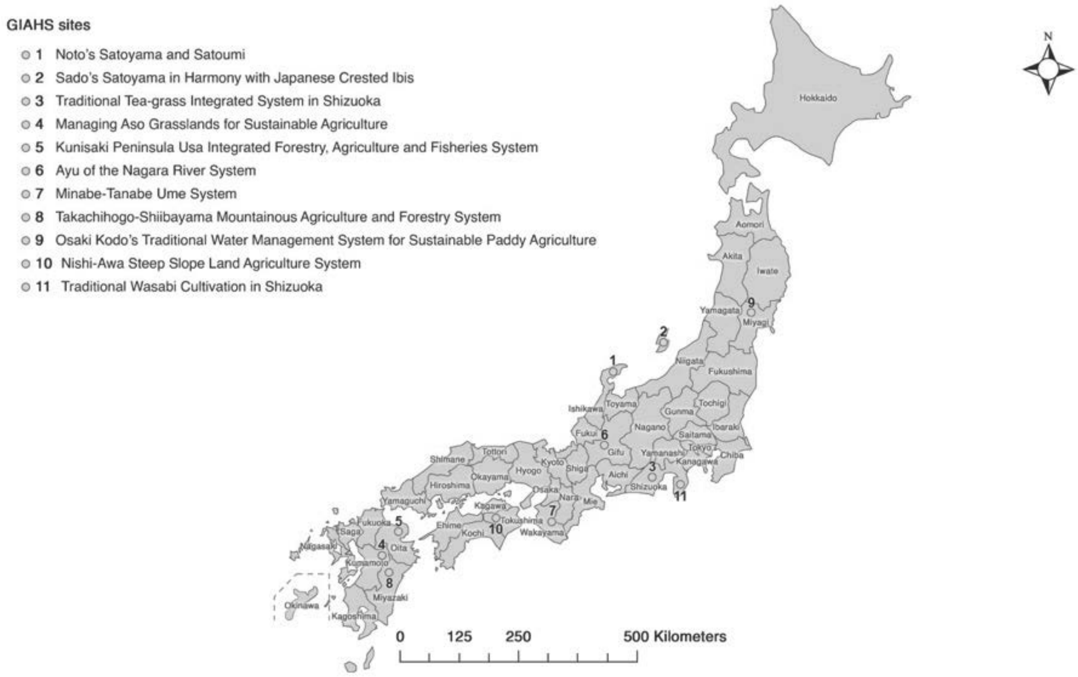

Figure 1. Japan's 11 designated GIAHS sites.

The FAO's initiative to designate GIAHS sites worldwide is essential to address various issues in the field of agriculture. Ever since it was launched in 2002, various studies have been conducted to analyze its sustainability, characterization, the vulnerability of sites, tourism management, biodiversity conservation, among others [13–17]. Most studies focused more on the macro perspectives of the GIAHSs and their potential environmental impacts, which thereby established a wide-ranging knowledge on GIAHSs as a supplement to what the FAO annually provides. These studies are also very useful in crafting environmental policies which can be used to alleviate increasing ecological threats [18]. Therefore, GIAHSs are recognized for their high contribution to rural revitalization and for ensuring the fulfillment of the multifunctional roles of agriculture, such as the creation of resilient landscapes, the preservation of cultural traditions, and the conservation of the natural environment, national land, and water resources [11]. With an expansive bank of research findings, it is ideal to think that this knowledge can actually be absorbed by one of the main caretakers of GIAHS sites: the farmers. However, there are limited studies that can support this. There is still limited literature focusing on micro perspectives, such as farmer participation and perceived GIAHS involvement.

In terms of socioeconomics aspects, it was observed in [19] that livelihood endowments and strategies directly affect GIAHS farmers' participation in eco-compensation policies. Particularly, the study found that the comprehensiveness of eco-compensation programs, land capital, and material capital are positive factors that provide farmers with incentives to participate in GIAHS conservation and agricultural production, whereas human capital was seen as a negative factor. With regards to sociocultural aspects, Kajihara et al. (2018) discussed the importance of understanding the relationship between culture and agriculture, and highlighted the need for the GIAHS criteria to incorporate culture for more effective management strategies [20]. It is important to note the interplay between farmers' cultural perspectives and their interaction with their immediate environment, which thereby affects their involvement and mindset towards GIAHS initiatives. This, in turn, contributes to honing the overall cultural development of GIAHS sites and their sustainability. When magnified on a global scale, Sun et al. (2019) conclude that more efforts are needed to understand agricultural heritage systems by combining traditional practices and international experiences [21].

Table 1. Japan's 11 designated GIAHS sites.

GIAHS Designated Sites	System Type	Designation Highlights	Region	Prefecture	Year of Designation
1. Noto's Satoyama and Satoumi	Landscape	Terraced rice-fields that represent the farming, fishing, and mountain villages indigenous to Japan	Noto	Ishikawa	2011
2. Sado's Satoyama in Harmony with Japanese Crested Ibis	Landscape	Biodiversity conservation in paddy fields, particularly Toki birds (Japanese crested ibises: *Nipponia nippon*)	Sado	Niigata	2011
3. Traditional Tea-grass Integrated System in Shizuoka	Farming method	Tea production and cultivation	Kakegawa	Shizuoka	2013
4. Managing Aso Grasslands for Sustainable Agriculture	Landscape	Vast grasslands used to raise cows and horses	Aso	Kumamoto	2013
5. Kunisaki Peninsula Usa Integrated Forestry, Agriculture and Fisheries System	Landscape	Linkage of small irrigation ponds that stabilize agricultural water supply	Kunisaki Peninsula Usa	Oita	2013
6. Ayu of the Nagara River System	Landscape	Active inland water fisheries and fishing of ayu (Japanese sweetfish: *Plecoglossus altivelis altivelis*)	Nagara River	Gifu	2015
7. Minabe-Tanabe Ume System	Landscape	Preservation of forest and Trees of ume (Japanese apricot: *Prunus mume*)	Minabe-Tanabe	Wakayama	2015
8. Takachihogo-Shiibayama Mountainous Agriculture and Forestry System	Landscape	Establishment of a composite management system of agriculture and forestry	Takachihogo-Shiibayama	Miyazaki	2015
9. Osaki Kodo's Traditional Water Management System for Sustainable Paddy Agriculture	Landscape	Utilization of various coping mechanisms to protect rice paddies	Osaki	Miyagi	2017
10. Nishi-Awa Steep Slope Land Agriculture System	Farming method	Cultivation of multiple crops in steep slopes	Nishi-Awa	Tokushima	2018
11. Traditional Wasabi Cultivation in Shizuoka	Farming method	Terraced wasabi (Japanese horseradish: *Wasabia japonica*) fields	Wasabi Cultivation Region	Shizuoka	2018

Farmer involvement and decision making can be influenced by a lot of internal and external factors [22]. Various studies have shown that farmers' decision-making processes are being affected by critical influential factors and that they vary on a case-by-case basis [23]. In a study conducted in the Philippines which tried to measure farmers' perspectives on a strict agricultural ban, it was found that satisfaction in the farming method used, knowledge about the main crop being grown, and personal experiences in farming are very important factors in their crop adoption decision-making process [24]. Indeed, the perception of being involved in a bigger cause is shaped by farmers' individual differences and environmental influences. This was shown in another study conducted in the Philippines that focused on farmers' perspectives on coexisting farming methods, which observed that groups of farmers are affected differently by internal and external factors [25]. Therefore, this enhances the need to understand farmers' perspectives and opinions, which in turn affect their involvement in various agricultural programs. To gauge the perceived involvement of farmers in this study, it would be vital to know their opinions towards important issues related to GIAHSs. Opinions have the capacity to shape perceptions, whether in an individual or community scale. In this study, three main factors were specifically studied, and they revolved around farmers' opinions towards the GIAHS's effects on youth involvement, the capability to enhance agricultural products, and tourism management.

2. Study Area and Methods

The study was conducted in Sado Island, which is located west of the Niigata prefecture shoreline (Figure 2). It is the sixth largest island in Japan, and has a complex ecosystem, with interdependent satoyama and satoumi landscapes. It is widely known as a natural habitat of endangered Japanese crested ibises (locally called Toki in Japanese) because of its satoyama and satoumi landscapes. The Japan Satoyama Satoumi Assessment (JASS) defines the former term 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" [12] (p. 2). Sado Island is also famous for its rice produce with the Toki branding, which supports the revival of the Toki birds [26]. Other agricultural crops are also grown, such as persimmons, apples, pears, cherries, oranges, strawberries, watermelons, shiitake mushrooms, among others. Since the island provides suitable habitats for the endangered Toki birds, public and private sectors poured in efforts to support Sado Island's biodiversity preservation through the environmental conservation agriculture (ECA) program [27], which was a huge factor in its designation as a GIAHS.

Sado Island was selected since it is one of the first GIAHSs in Japan and because it is well supported by the local and national governments. A lot of people contribute to its development, such as the active local community, ECA-supportive consumers, and the research community, who all value the protection of Toki birds. Sado Island is a vulnerable rural region affected regularly by natural disasters, which cause crop failures and livelihood insecurity. One way to alleviate these problems are the Toki bird conservation efforts, which led to the production of certified rice, branded as Tokimai in 2008. It is marketed with a premium price and a portion of the income goes towards to conservation of the Toki birds [27]. This rice is produced in ECA lands which the Toki birds use as feeding grounds throughout the year. Sado Island is a GIAHS where people and Toki birds (wildlife) are living together in harmony. These characteristics of Sado Island warrant conducting research with the objectives mentioned above.

A questionnaire survey method was employed to collect data from ECA farmers in Sado Island. After prior discussion about the survey with key persons, the research objectives and questionnaire were explained 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), in cooperation with the Sado Municipality Agriculture

Policy Division, in February 2020. The board made the resolution to allow the survey and 415 questionnaires were handed to Toki-to-kurasu-satozukuri council members during the annual general meeting. A total of 279 (67%) responses were received by the end of April 2020.

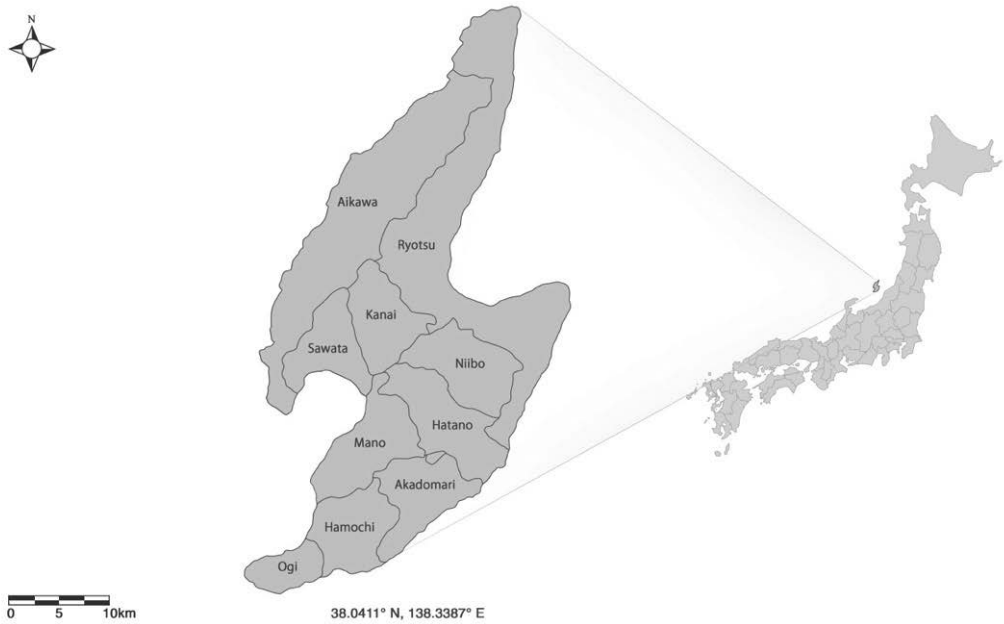

Figure 2. Map of Sado Island.

GIAHS-related factors (i.e., farmers' opinions towards the GIAHS's effects on youth involvement, the capability to enhance agricultural products, and tourism management) were incorporated in the questionnaire using a three-point ordinal scale (1–strongly yes, 2–not sure, and 3–strongly no). Sociodemographic factors were also gathered via the questionnaire to obtain baseline data for the farmers. Data were analyzed using ordinal logistic regression and a general linear model in SPSS v.27. Tests of parallel lines and model fit were conducted to determine whether statistical assumptions were met. Lastly, qualitative questions were gathered regarding the farmers' opinions on the impact of the GIAHS on youth involvement, Sado Island branding, and tourism management. The responses given in local Japanese were translated to English by the authors.

3. Results

To understand the current situation of farmer involvement with the GIAHS in Sado Island, their perceived level of involvement was determined using a three-point scale, which revealed that only 43.7% (122 of 279) of the sampled farmers feel that they are involved in the GIAHS, while 56.3% (157 of 279) feel uninvolved or unsure towards the GIAHS (Table 2). Similarly, only 38.7%, 59.1%, and 49.8% of the farmers feel that the GIAHS gives pride and confidence to youths, enhances agricultural products/brand, and promotes tourism, respectively. When viewed at the perspective of their current farming method, which is predominantly special farming (77.3%) (i.e., it complies with GIAHS regulations) and organic farming (10.8%), the farming method and high frequency of farmers who feel unsure or uninvolved towards the GIAHS do not appear to agree with each other.

Table 2. Frequency distribution table for GIAHS-related and sociodemographic factors among Sado Island farmers.

Variable	Frequency	Percentage (%)
GIAHS involvement		
Strongly yes	122	43.7
Not sure	129	46.3
Strongly no	28	10.0
TOTAL:	279	100.0
Opinion on the GIAHS giving pride and confidence to youths		
Strongly yes	108	38.7
Not sure	138	49.5
Strongly no	33	11.8
TOTAL:	279	100.0
Opinion on the GIAHS enhancing agricultural products/brand		
Strongly yes	165	59.1
Not sure	90	32.3
Strongly no	24	8.6
TOTAL:	279	100.0
Opinion on the GIAHS promoting tourism		
Strongly yes	139	49.8
Not sure	98	35.1
Strongly no	42	15.1
TOTAL:	279	100.0
Farming method		
Special farming [a]	215	77.3
Organic farming [b]	30	10.8
Eco-farming or related [c]	26	9.4
Conventional farming [d]	7	2.5
TOTAL:	279	100.0
Environment conservation agriculture's effects on climate change *		
As an adaptation	121	43.4
Reducing the effect	71	25.4
No effect	64	22.9
Others	9	3.2
Selling place for products *		
Agricultural cooperatives	260	93.2
Direct to consumers	60	21.5
Michi-no-eki (roadside farmers' market)	11	3.9
Supermarket	4	1.4
Restaurant	2	0.7
Internet	2	0.7
Central market	1	0.4
Food processors	1	0.4

* Multiple answer. [a] Special farming: uses 50%–80% less fertilizer and pesticide than the conventional farming practice of the locality, and complies with GIAHS regulations. [b] Organic farming: certified as organic by Japanese Agricultural Standards (JAS), or no JAS certification but do not use chemical fertilizers and synthetic pesticides. [c] Eco-farming or related: environmentally friendly methods based on other standards. [d] Conventional farming: uses chemical fertilizers and pesticides prescribed and practiced in the region.

3.1. Relationship between GIAHS Involvement and Youth Involvement, Tourism, and Branding

To provide an explanation for this observation, various sociodemographic, and GIAHS-related factors relating to Sado Island farmers were used as predictors against their level of perceived involvement towards the GIAHS. The three GIAHS factors evaluated in this study were the common themes of Japanese rural farming, namely: youth involvement, brand promotion, and tourism enhancement [28–30]. All three variables were found to be positively related with the GIAHS involvement score, such that farmers who feel that the GIAHS does not promote youth involvement, promote Sado Island brand, and enhance tourism are 17.4%, 38.8%, and 49.4% more likely to feel uninvolved with the GIAHS (Table 3).

Table 3. Relationship between various GIAHS variables and the farmers' perceived level of GIAHS involvement using ordinal logistic regression [a].

Predictor [b]	Estimate	Odds Ratio	Significance
GIAHS giving pride and confidence to youth in Sado Island	1.747	17.43%	0.000 **
GIAHS enhancing agricultural products and brand of Sado Island	0.946	38.83%	0.005 **
GIAHS promoting tourism in Sado Island	0.706	49.36%	0.004 **

[a] Link function: Cauchit: $\tan(\pi(F_k(x_i) - 0.5))$. [b] Test of parallel lines: Chi-square = 1.750, df = 3, sig = 0.626. Model fit: Chi-square = 117.612, df = 3, sig $\leq$ 0.001. ** significant at $p < 0.01$.

3.2. GIAHS Involvement and Youth Inclusivity

Eight sociodemographic factors were used as predictors of the Sado Island farmers' perceived level of GIAHS involvement (Table 4). The effects of age, farm/paddy area, yield, climate change effect perception, and farming method were found to have no significant impact on perceived GIAHS involvement. On the other hand, farmers who reported to be participating in exchange programs, either voluntarily or with subsidy, are more likely to feel involved with the GIAHS. In terms of age, 80.3% (224/279) of the sampled Sado Island farmers are 60 years old and above. Of the 15 farmers who are 49 years old or younger, only one third (5/15) reported being involved in the GIAHS. This underrepresentation of youth in GIAHS activities appears to have contributed to the dilution of the effect of age on GIAHS involvement.

Table 4. Relationship between various sociodemographic variables and the farmers' perceived level of GIAHS involvement using a general linear model.

Response Variable: GIAHS Involvement		
Predictor	**Estimate**	**Significance**
Age	3.519	0.111
Farming experience	−0.077	0.119
Farmland size	0.058	0.110
Paddy land size	0.119	0.057
Paddy yield	−0.143	0.371
Perceived intensity of climate change effect	−0.042	0.499
Farming method	0.045	0.749
(1) Organic farming	−0.012	0.393
(2) Special farming	−1.03	0.322
(3) Eco-farming or related	−1.166	0.984
(4) Traditional farming	0.019	-
Exchange program(s) participation/promotion	-	0.238
(1) Not participating	−1.514	0.167
(2) Participating with subsidy	−1.838	0.036 *
(3) Participating voluntarily	−2.199	0.028 *
(4) Participating with pay	−2.311	0.617
(5) Others	−0.238	-

* Significant at $p < 0.05$. White test for heteroskedasticity: Chi-square = 117.264, df = 107, sig = 0.234. Lack of fit test: F = 1.051, sig = 0.486.

3.3. GIAHS Involvement in Tourism and Branding

Sado Island has become known for their Tokimai brand of rice. This integration of the conservation of the local Toki bird population with local farming has contributed to the 0.6% growth rate of tourism in the Niigata prefecture, which amounts to roughly 400,000 guests using local accommodation since the introduction of the program [31]. This also helped to address the problems of livelihood insecurity in the island, as raised by Su and Kawai (2009) [27]. In this study, the effects of farmer expectations on ECA and selling location on perceived GIAHS involvement were also tested. In terms of selling location, farmers who sell directly to consumers were more likely to perceive themselves to be involved with the GIAHS than those who sell at other locations (Table 5).

Table 5. Relationship between various selling locations and the farmers' perceived level of GIAHS involvement using a general linear model.

Response Variable: GIAHS Involvement		
Predictor	**Estimate**	**Significance**
Direct to consumers	−0.201	0.050 *
Supermarket	0.199	0.552
Restaurant	0.679	0.216
Agricultural cooperatives	0.019	0.907
Central market	0.257	0.709
Michi-no-eki (roadside farmers market)	0.041	0.85
Food processors	−0.501	0.449
Internet	−0.34	0.53

* Significant at $p < 0.05$. White test for heteroskedasticity: Chi-square = 10.344, df = 13, sig = 0.666. Lack of fit test: F = 1.402, sig = 0.224.

In addition to micro-level predictors, the effect of farmer expectations of ECA on GIAHS involvement was also tested (Table 6). In line with the theme of GIAHSs that relates to ecological conservation, farmers who are participating in the ECA program for carbon sequestration and conservation of biodiversity reasons were more likely to feel involved with the GIAHS, which agrees with previous studies [9,13]. In addition, farmers who are doing ECA to promote the local industry are also more predisposed to feel involved with the GIAHS, which also agrees with other studies, such as in Vafadari (2013), which identifies tourism as a key stimulant of local industry because it opens new jobs and enhances the attraction of rural lifestyles in GIAHS communities [32]. Indeed, the Sado Island tourism webpage features Toki Museum tours, sightseeing, and forest parks [33].

Table 6. Relationship between farmer expectations of ECA and the farmers' perceived level of GIAHS involvement using a general linear model.

Response Variable: GIAHS Involvement		
Predictor	**Estimate**	**Significance**
Carbon sequestration	−0.304	0.012 *
Conservation of biodiversity	−0.252	0.005 **
Conservation of water quality	−0.005	0.956
Underground water terrain improvement	−0.333	0.070
Add value in quality of products	0.063	0.455
Decrease effect of weather hazards	0.09	0.518
Increase farm related income	0.121	0.152
Promote local industry	−0.224	0.019 *
Retain residents in rural area	−0.014	0.942
Others	−0.275	0.226

* Significant at $p < 0.05$; ** significant at $p < 0.01$. Breush–Pagan test for heteroskedasticity: Chi-square = 2.820, df = 1, sig = 0.093. Lack of fit test: F = 1.087, sig = 0.323.

To determine if the farmers' global perspective on ECA activities influences their perceived involvement towards the GIAHS, their answer regarding the effect of ECA on climate change was used as predictors for their level of perceived involvement with the GIAHS. Here, farmers who believed that ECA is an adaptation to climate change were twice as likely to feel involved with the GIAHS than those who do not (Table 7). This agrees with the earlier observation on farmer expectations regarding ECA. Testimonials such as that by Respondent 153 reflect this trend from a farmer's point of view:

> *"Produce food that suits climate change. Sell them fresh with safety and good taste. This should be managed through institutional strategy under good leadership. Hotels should use the branded rice produced in Sado."*

Table 7. Relationship between farmer-perceived effects of ECA on climate change and the farmers' perceived level of GIAHS involvement using ordinal logistic regression [a].

Response Variable: GIAHS Involvement			
Predictor [b]	**Estimate**	**Odds Ratio**	**Significance**
ECA as an adaptation to climate change	−1.09	297.43%	0.002 **
ECA reduces the effect of climate change	−0.665	194.45%	0.068
ECA has no impact on climate change	−0.184	120.20%	0.618
Others	−0.027	102.74%	0.971

[a] Link function: Cauchit: $\tan(\pi(F_k(x_i)-0.5))$. [b] Test of parallel lines: Chi-square = 0.168, df = 4, sig = 0.997. Model fit: Chi-square = 22.906, df = 4, sig $\leq$ 0.001; ** significant at $p < 0.01$.

4. Discussion

Various studies have emphasized the importance of analyzing farmers' knowledge and opinions which heavily influence their involvement and productivity in different aspects of agriculture [34–36]. In Japan, which is dominated by landscape types that give high value to the linkage of nature, biological diversity, and its surrounding communities, GIAHS sites have been continuously increasing since 2011 [11]. While it is good to see the increase in GIAHS sites in Japan and worldwide, the main caretakers of rural communities—the farmers situated in these sites—should equally be considered. As Rhoades (1984) argues, a full circle should be completed when it comes to the implementation of agricultural technologies and activities, such that farmers are equally involved and a part of the process [36]. Otherwise, the diffusion of technologies would face difficulties and farmers may tend to feel uninvolved, thereby leading to less synchronicity between the agricultural initiative and its target stakeholders.

In this study, the Sado Island's farmers' perceived involvement in the GIAHS was explored, and it showed that more than half of the 279 farmers interviewed (56.3%) feel unsure or uninvolved, despite being situated in a decade old GIAHS site. This appears to be contradictory with the primary farming methods being used by the farmers, which focus on ECA and comply with GIAHS regulations. To further understand this disconnect, the study analyzed farmers' perceived involvement as it related to three common themes of Japanese rural farming, which are: youth involvement, brand promotion, and tourism enhancement. It was found that all three factors are positively related to the farmers' perceived GIAHS involvement, thereby accentuating their importance when it comes to crafting policies aiming to increase farmer involvement in the GIAHS.

Looking at the age demographics, a huge percentage (80.3%) of farmers are 60 years old and above, which highlights the lack of youth involvement, not only in GIAHS sites, but in various agricultural sectors in Japan. Recent papers, such as that by Reyes et al. (2020), have indeed highlighted the negative effects of farmland abandonment and the underuse of farming resources resulting from Japan's decreasing and aging rural population [13]. This same sentiment has been observed among the submitted testimonials of the interviewed farmers, such as that by Respondent 269, who stated the following:

> *"There are many abandoned lands due to lack of successors. Lands are overgrown by various weeds, such as* Solidago canadensis var. Scabra, Ambrosia artemisiifolia *which flowers yellow during autumn and winter, making it look ugly or not cared for,*

> *which is far from the image of GIAHS. First, such land should be managed properly and brought under proper cultivation."*

Sado Island farmers also recognize the alarming issue of farmer shortage in the future because of the increasing trend of youth exodus; hence, they are also voicing their opinions on how to attract people to farm in Sado Island. The narrative of Respondent 131 clearly shows this:

> *"There will be a shortage of people who will continue farming in the near future. Attract the people who are fed up of city life and loves the countryside to create a natural living environment. People with allergies, retired life, and kids can come to live in Sado. This will create circulatory connectivity in different aspects between Sado and the cities, which will eventually attract the youths to Sado, increase their movements to and fro, making the livelihood more active and connected with the cities as well."*

This highly agrees with the findings of Usman et al. (2021), who highlight the desperate need of rural areas for agricultural workers in connection with Japan's aging farmers' population, to mitigate the increase in Japan's dependency for international food products and high import expenses [37].

Further analyses have shown that farmers' participation in exchange programs also increases their likelihood to feel involved with the GIAHS. To this end, participation in exchange programs may thus play a key role in not only encouraging the younger generations of farmers, but also enhance the transfer of intangible farming inputs, such as techniques and managerial skills [30]. This view was also shared by Respondent 276, who stated that:

> *"There is a need to secure people to continue GIAHS. All the GIAHS sites in Japan should come together to promote and enhance it through public relations in universities and colleges and make it part of lectures to get the interest of students who would work on it in the future. First, orient them about GIAHS in general and different GIAHS in Japan, and let them participate in field studies and internships in a GIAHS of their choice for them to interact and learn the local culture, as well as experience the local livelihoods. Afterwards, let them reflect about it and how they can be involved in it in the future to improve."*

This theme was also explored by Yamashita (2021), who focused on how Japanese traditions can be saved by analyzing urban university students' participation in rural festivals [38]. Interestingly, the case site of the study is also a GIAHS in Japan, particularly the Noto region in the Ishikawa prefecture. The study recommended that better collaborations should be established between urban youths and their participation in rural festivals, which means that more focus should be given in the management of festivals and how outside support can be further increased. These can help alleviate the discontinuation of rural festivals and loss of cultural values. This is also in connection with what Sado Island farmers are voicing out in this study, which is the need to attract youths to Sado Island, thereby implying that they are also aware of the negative consequences if the common trends of youth exodus and rural disinterest will continue.

The narratives of Sado Island farmers and various literature that established the interlinked issues of farmland abandonment, the aging population, youth exodus, and farmer shortages clearly show the need for more policies that would cater to the strengthening of Japan's agriculture. Based on this paper's findings, participation in exchange programs may increase the chances of attracting people, especially the youth, to rural areas and help them become more involved in addressing issues in the field of agriculture. With the increase in youth participation, modern solutions can also be applied as rural areas struggle to adapt in the changing world.

With a high growth rate of tourism in the Niigata prefecture, it is not surprising that farmers in this study feel more involved in the GIAHS when they sell directly to consumers. However, looking at the frequency distribution, selling to agricultural cooperatives was the most predominant choice among the farmers (93.5%). This inconsistency was elaborated upon in the testimonials of the farmers, with many entries commenting on the poor uptake of the Tokimai brand across other industries and markets, such as restaurants and supermarkets. This was clearly shown in the response of Respondent 121, who stated that:

> *"Last year, I participated in the public relations sale of rice in Tokyo station, along with the city officers. Nearly 100% of the passers-by did not know about GIAHS, which is so unfortunate."*

A similar sentiment has been shared by Respondent 141:

> *"GIAHS alone will not enhance the tourism to brand the hotels, other facilities and services using the branded products of the island."*

Respondent 162 also shared some sentiments on how the GIAHS should complement agriculture:

> *"It is good to make use of GIAHS for tourism development in the island. However, it is not clear how it helps in enhancing the island's farming and primary industry. If there is no clear picture/explanation how GIAHS and tourism development can enhance farming, the farmers and youth may not be interested (e.g., How will hotels use rice, vegetables, and fish produced in the island to serve the tourists with a delicious and attractive dish?). It is said that bigger hotels don't have repeaters (supposedly the food they provide is not delicious) while the homestay pensions serving local food have repeaters. City dwellers visit Sado not only for its nature but also for its food, as well as its hospitable people with warm personalities (heard that the cooks in bigger hotels are dispatched from Kansai (western part of Japan) or foreigners). The concept should be not agriculture for tourism but tourism for developing agriculture."*

These narratives are in line with the point raised by Ohe (2013), who highlights the generation gap between younger and senior generations in recognizing the value of rural tourism, as well as the urban–rural mismatch with regards to rural tourism desires and expectations [29].

This study also found that the Sado Island farmers give high importance to ECA as an adaptation to climate change, thereby highlighting how farmers also prioritize their concern for the environment, in addition to their economic needs. This is also in line with their ECA expectations to promote their local industry, sequestrate carbon, and conserve water quality. Various studies have also shown that farmers' abilities and individual decisions to adopt environmentally friendly farming methods contribute a lot to mitigating climate change [39,40]. Therefore, maintaining this mindset in farmers is crucial and more studies should be conducted on how to sustain it.

5. Conclusions

Results from the survey in this study have shown a higher incidence of reduced farmer involvement in the GIAHS. While it is one of the direct goals of GIAHS designation to promote awareness and visibility for the farmers working in these sites, results from this study do not support the notion of a direct relationship between farmer visibility and farmer involvement as previously hypothesized. To further understand this observation, the effects of various sociodemographic and GIAHS factors on farmers' perception towards GIAHS involvement were tested. Negative perceptions of the promotion of youth involvement, Sado Island branding, and tourism management has an enhancing effect on reduced farmer perceptions towards GIAHS involvement. Further evidence presented through the various farmer responses corroborate this observation, prompting an integration of farmer-level input towards the community-level implementation of GIAHSs.

Upon evaluation of the effects of farmer expectations on their perceived GIAHS involvement, it was found that the promotion of local industry has an enhancing effect on farmer involvement. This observation hints at the need for better diffusion of the resulting branding (Tokimai) from the GIAHS initiative to other local industries in Sado Island, as well as the need to target consumers who may not know about Tokimai. Based on farmer responses, there is a need for better uptake of the Tokimai branding across different local industries, such as restaurants, hotels, and supermarkets, for the continuous development of farmer communities and GIAHS sites.

The enhancing effect of carbon sequestration and biodiversity conservation towards farmer perceptions on GIAHS involvement was also shown, as expected of an environment-conscious community. This is in alignment with the observation that farmers who feel that ECA is an adaptation to climate change have a higher likelihood of feeling involved with the GIAHS. A study focusing on the effects of various farmer-related factors towards ECA continuation may also provide additional insights on the holistic view of the integration between farmer activities with biodiversity conservation.

While the results of the study cannot be used to fully represent other GIAHS sites in Japan because of the differences in landscape types, locations, and typologies, it can serve well as a reference for local government officials and policymakers on strengthening and developing the GIAHS efforts across Japan, and other countries as well. The study further encourages more research on other GIAHS sites in Japan, with more robust samples and results, which can then contribute to their sustainability. Moreover, studies on GIAHSs around the world with similar characteristics will be needed to enhance the management of GIAHS sites, in connection with the findings of this paper. When magnified on a global scale, the themes explored in this study would lead to a deeper interplay between farmers' knowledge and perception and GIAHS objectives.

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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).

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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.

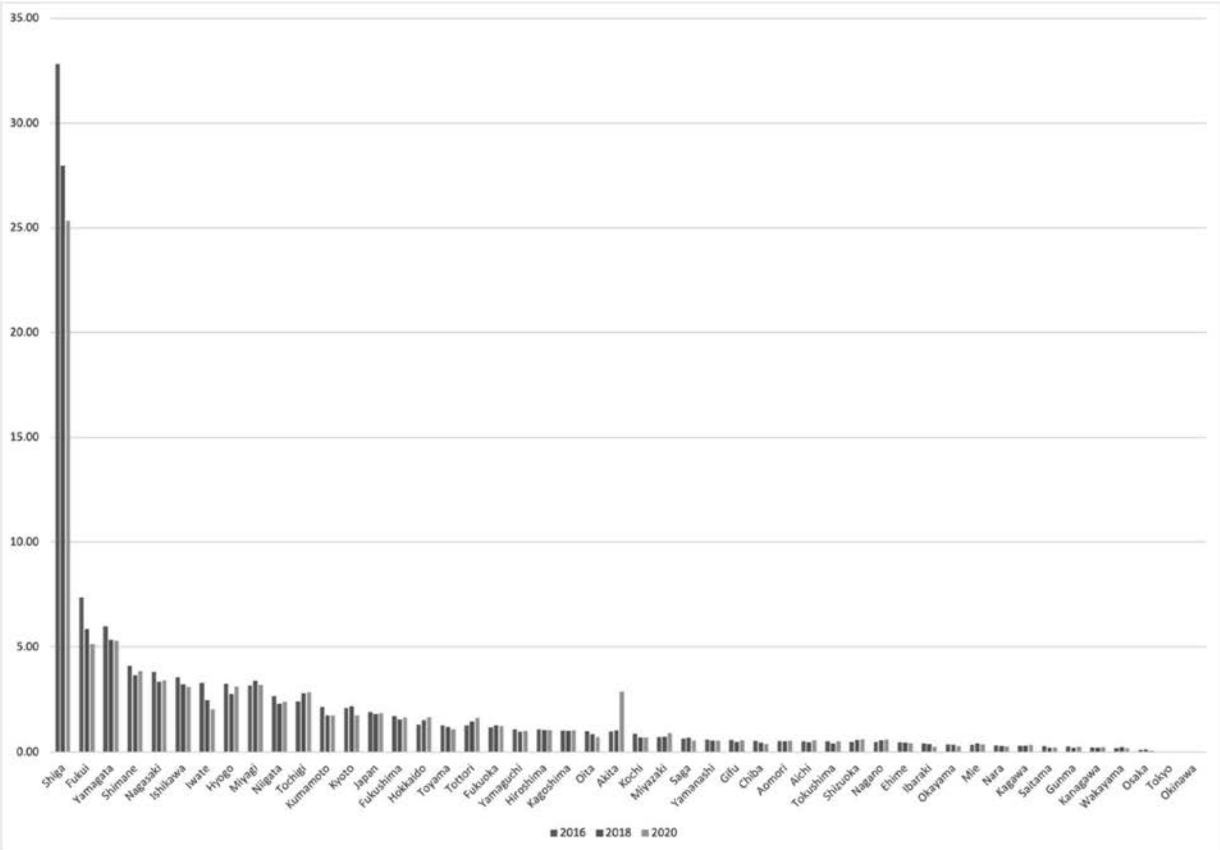

Figure 1. Percentage of ECA utilization in Japan.

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.

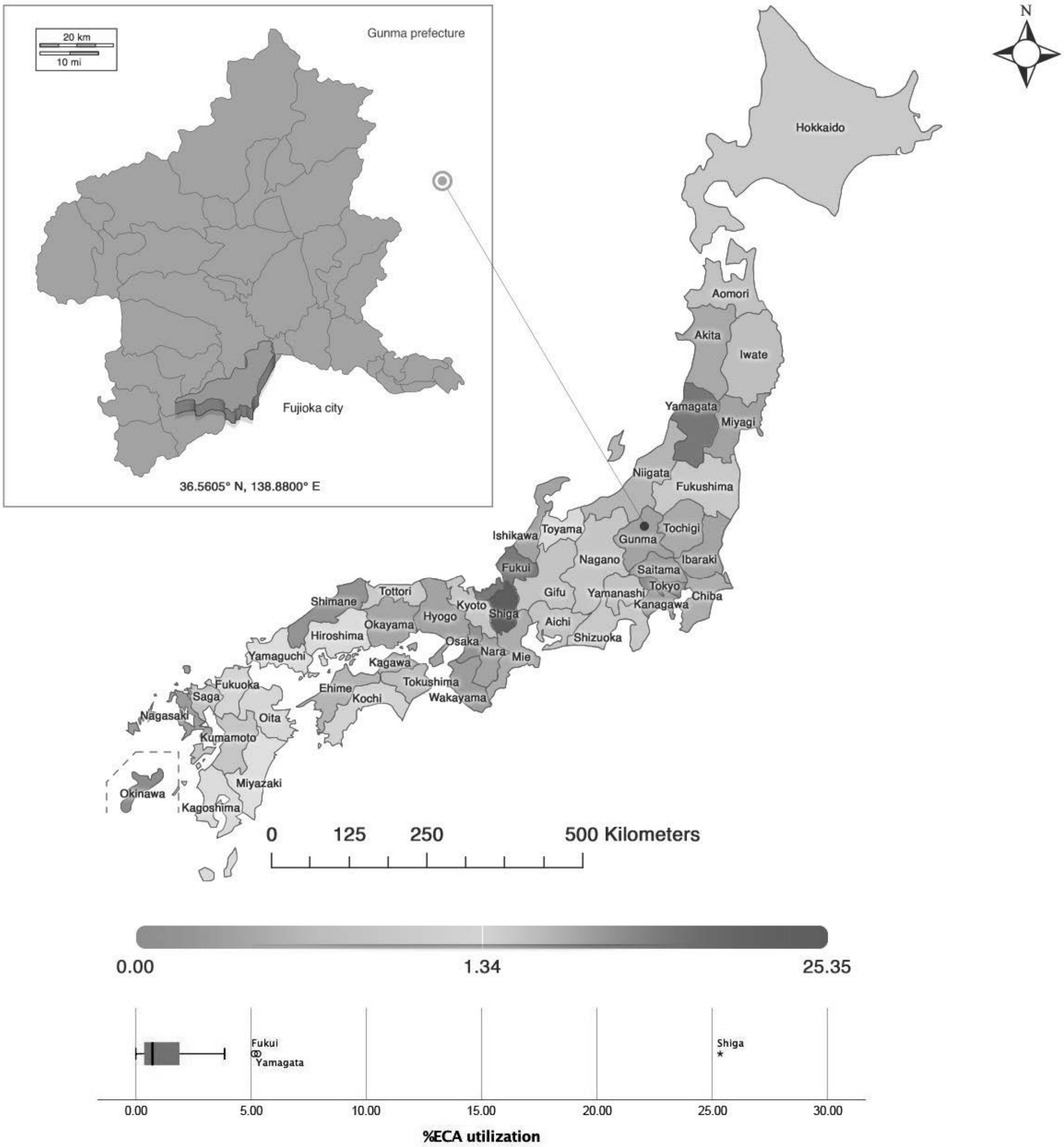

Figure 2. Heatmap showing percentage of ECA utilization per prefecture in Japan and Fujioka city in Gunma prefecture (chosen research locale).

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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Supplementary Table S1. Socio-demographic characteristics of the sampled farmers in Fujioka, Japan.

Variable	Frequency (n=46)	Percentage (%)
Age		
35-44	3	6.5
45-54	3	6.5
55-64	13	28.3
65-74	20	43.5
75 and above	7	15.2
Sex		
Male	42	91.3
Female	4	8.7
Farming experience		
9 years and below	6	13.0
10-19	10	21.7
20-29	6	13.0
30-39	6	13.0
40 years and above	18	39.1
Farm type		
Family farm	43	93.5
Company farm	3	6.5
Family farm purpose *		
Self-consumption	20	43.5
Selling	25	54.3
Selling place for products*		
Agricultural corporations	30	65.2
Direct to consumers	19	41.3
Michi-no-eki (roadside farmers' market)	11	23.9
Supermarket	4	8.7
Food processors	4	8.7
Restaurant	3	6.5
Central market	3	6.5
Farming method		
ECA	21	45.7
Not ECA	25	54.3
Number of other family members whose main job is not farming		
0	23	50.0
1	14	30.4
2	6	13.0
3	1	2.2
4	1	2.2
8	1	2.2

* Multiple answer.

Supplementary Table S2. ECA-related variables of the sampled farmers in Fujioka, Japan.

Variable	Frequency (n=46)	Percentage (%)
ECA interest		
High	17	37.0
Not high	29	63.0
Interest to discuss or learn about ECA opportunities		
Yes	12	26.1
No	34	73.9
ECA continuation		
Yes	11	23.9
No	35	76.1
Wish for farming *		
Area no change, same farming method	20	43.5
Area no change, but towards ECA	7	15.2
Decrease area, same farming method	6	13.0
Will expand area using the same farming method	3	6.5
Will expand current farming towards ECA	1	2.2
Decrease area, towards ordinary farming	1	2.2
Reason for ECA continuation *		
To improve local and global environment	14	30.4
To supply better products	11	23.9
Self-health	9	19.6
To build trust with consumers	7	15.2
To decrease production cost of fertilizers and pesticides	3	6.5
Demand is high	2	4.3
Good/high price	1	2.2
Expectation from ECA *		
Conservation of biodiversity	18	39.1
To add value to quality of products	18	39.1
Conservation of water quality	11	23.9
Promote local industry	10	21.7
Increase farm related income	9	19.6
Retain residents in rural area	8	17.4
Carbon sequestration	7	15.2
Retain underground water	7	15.2
Decrease effect of weather hazards	4	8.7
ECA subsidy		
Never	39	84.8
Have been getting subsidy from before and continues up to date	6	13.0
Used to get before but not anymore	1	2.2
Participation/promotion of exchange programs		
No	38	82.6
Yes, with subsidy	1	2.2

Yes, voluntarily	3	6.5
Yes, with pay	3	6.5
Others	1	2.2
Kind of exchange program *		
Direct sale to consumers and harvesting	8	17.4
With schoolchildren's extracurricular activities	8	17.4
Forums with buyers, companies, or restaurant owners	5	10.9
Farming experience for all	5	10.9
Local residents (i.e., direct sale mini markets)	4	8.7

* Multiple answer.

Supplementary Table S3. Climate change-related variables of the sampled farmers in Fujioka, Japan.

Variable	Frequency (n=46)	Percentage (%)
Climate change has a very high impact on agriculture		
Yes	28	60.9
No	18	39.1
Effects of climate change *		
Increase in temperature and extremely hot days	35	76.1
Heavy torrential rain; flooding	28	60.9
Change in season duration	24	52.2
Typhoons, cyclones, or tornadoes	21	45.7
Damage to farm products	14	30.4
Change in distribution of plants/crops	12	26.1
Drought	11	23.9
Damage to land/farmland	10	21.7
Melting of glaciers, sea-level rise	8	17.4
Damage to houses/buildings	2	4.3
Adaptation being undertaken against climate change effects on agriculture *		
Planting high-temperature tolerant varieties	22	47.8
Water management	19	41.3
Ameliorate pest/diseases	13	28.3
Change in planting time/season	8	17.4
Change land use pattern	7	15.2
Soil management	5	10.9
Choose different crop	3	6.5

* Multiple answer.

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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

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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.

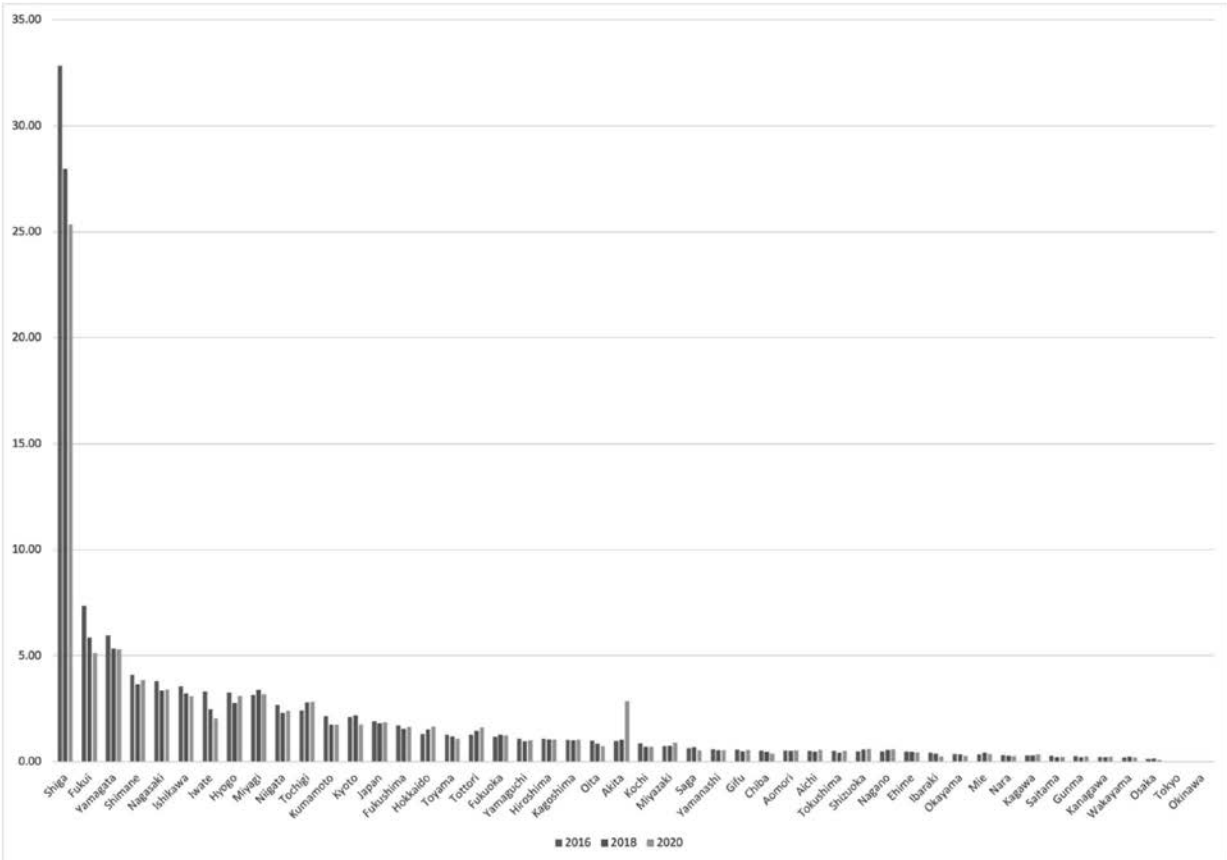

Figure 1. Percentage of ECA utilization in Japan. Source: Maharjan et al. (2022), with permission [13].

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.

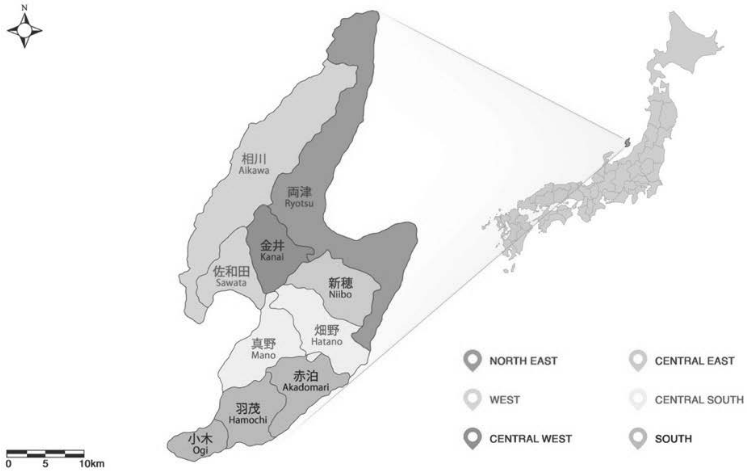

Figure 2. Map of Sado Island showing areas included in the study.

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].

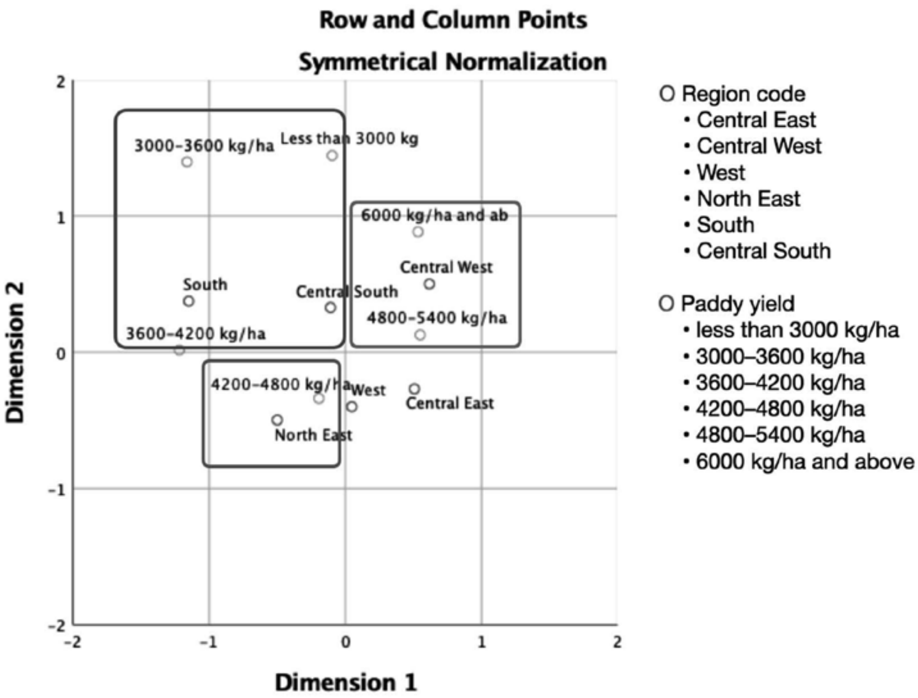

Figure 3. Biplot of region and paddy yield.

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.

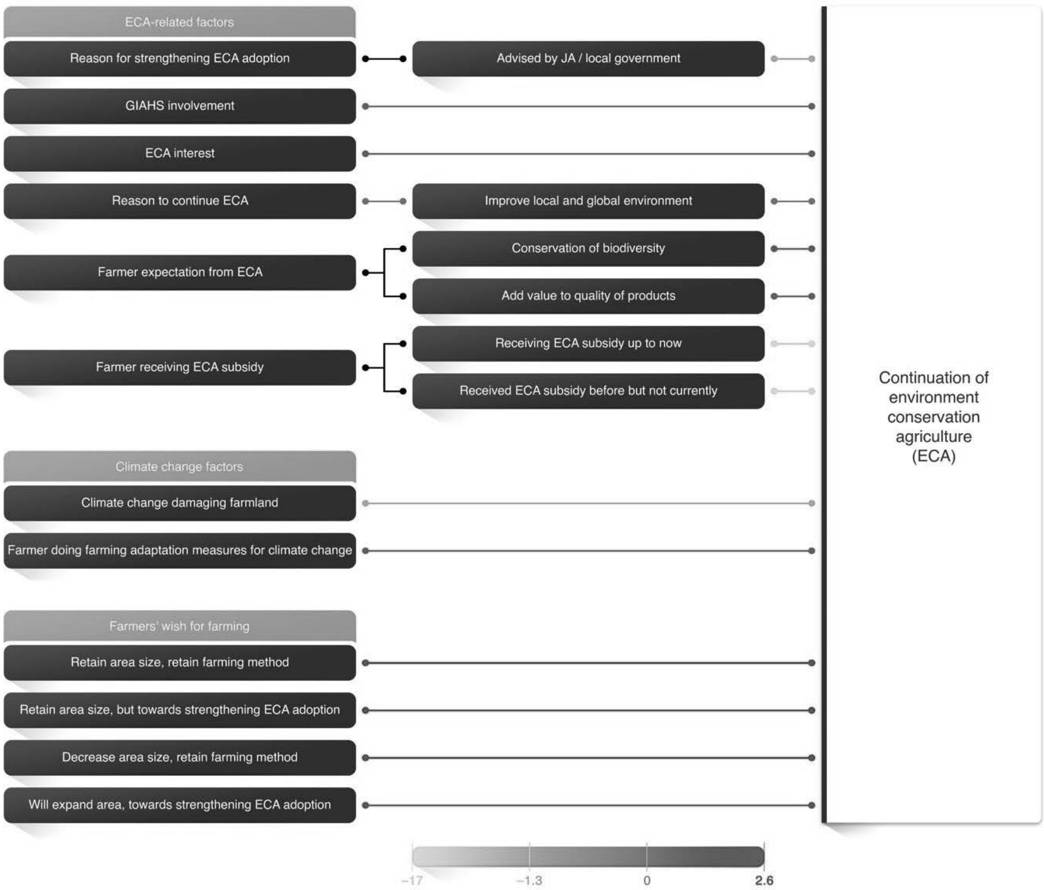

Figure 4. Relationship of identified factors affecting ECA continuation. The connecting lines in red indicate the positive intensity of the relationship with ECA continuation, while green indicates the negative intensity of the relationship.

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.

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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.

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気候弾力性のある農業に関する研究

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