Sustainable Agriculture and Biodiversity Conservation in Japan

Subjects: Others

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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. 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. Japan has been proactive in preserving endangered species, such as butterflies vascular plants, and birds

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

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][2][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][13][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].

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 entry 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.

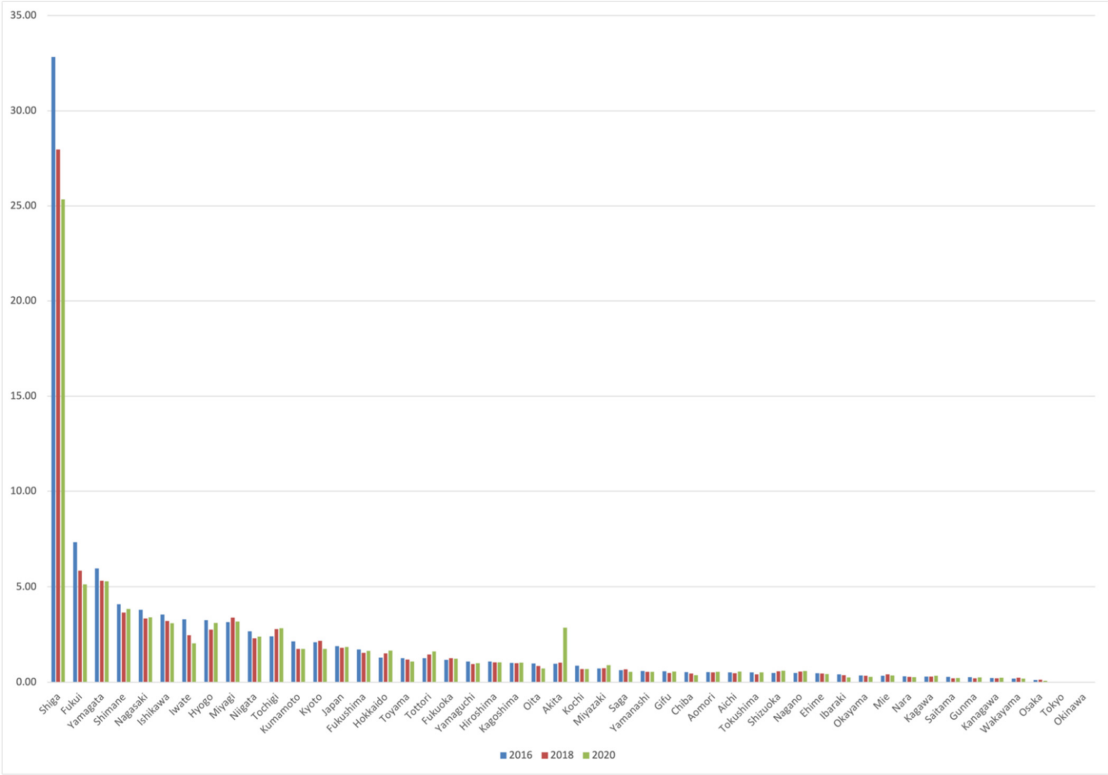

Figure 1. Percentage of ECA utilization in Japan.

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, researchers 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 researchers 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 entry.

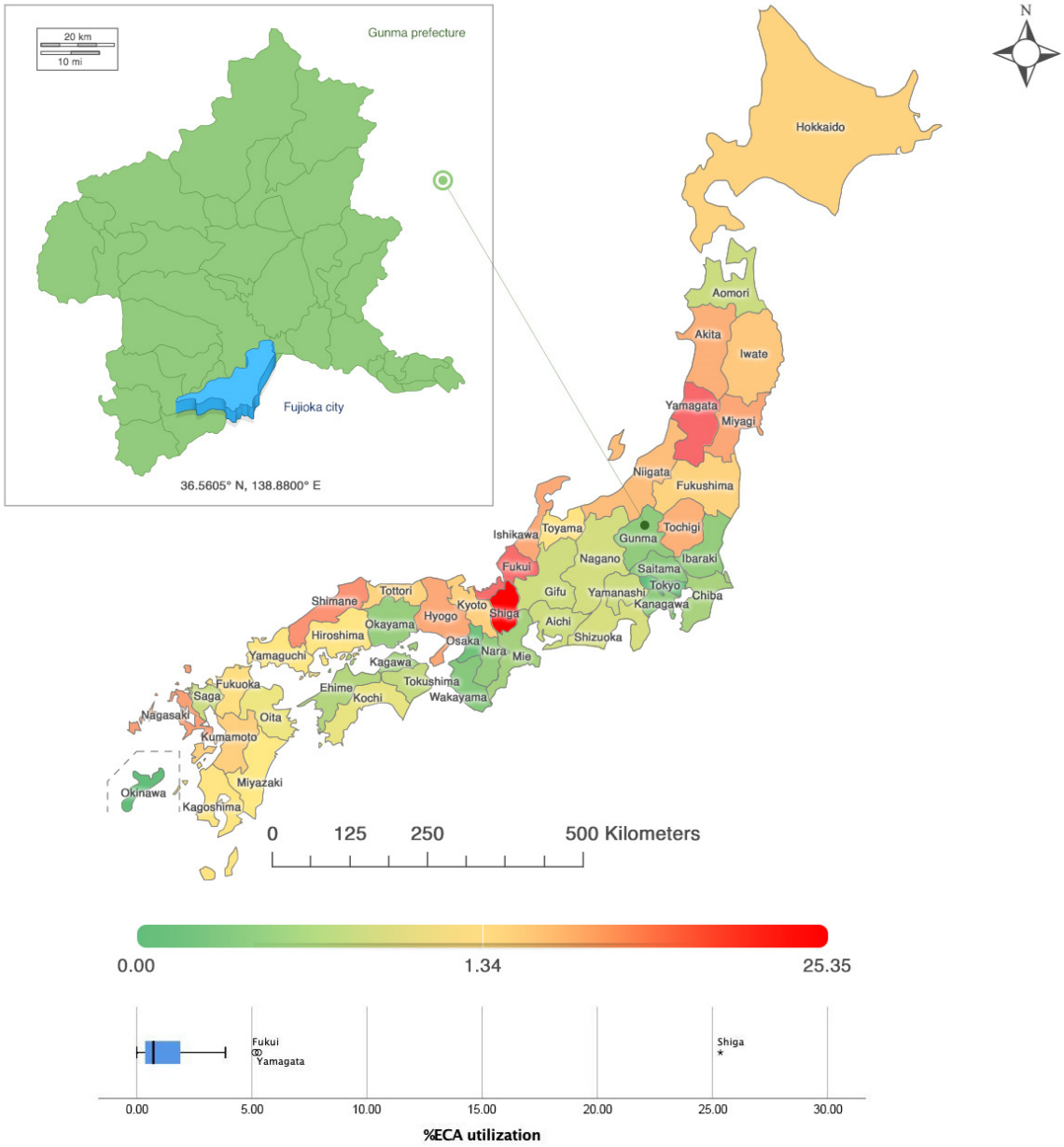

Figure 2. Heatmap showing percentage of ECA utilization per prefecture in Japan and Fujioka city in Gunma prefecture (chosen research locale).

2. 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 entry 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.

3. 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.

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