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Enhancing Sustainability in Traditional Agriculture: Indicators for Monitoring the Conservation of Globally Important Agricultural Heritage Systems (GIAHS) in Japan

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Abstract: The advent of modern technology in agriculture has increased the efficiency of our food production but also poses pressures on the sustainability of our planet. The Globally Important Agricultural Heritage Systems (GIAHS) of the Food and Agriculture Organization of the United Nations (FAO) has been developed to safeguard traditional agricultural systems of global importance, which harnesses the harmonious relationship between people and nature. First launched in the World Summit on Sustainable Development in 2002 to address the sustainable development of family agriculture and traditional farming practices for developing countries, it now has 59 sites located in 22 different countries as of March 2020. Despite almost two decades of its implementation, FAO has not set any requirements nor given guidance on monitoring of the conservation of GIAHS, but leaves it to the discretion of each GIAHS site to conduct voluntary self-evaluation. This study is a comprehensive review of all 11 GIAHS application proposals in Japan, which aims to (1) conduct characteristic analysis to identify elements and perspectives related to the GIAHS selection criteria, (2) understand the motivations and socioeconomic conditions, including challenges and opportunities related to the GIAHS application, so as to (3) propose a set of indicators and perspectives to address these challenges and opportunities for improving the application, monitoring, and management of the GIAHS. The study finds that motivations for applying to GIAHS designation are primarily driven by push factors of abandonment of traditional farming practices and farmlands and underuse of farming resources resulting from Japan's decreasing and aging rural population, as well as the pull factor of biodiversity conservation. The importance of continuing traditional farming practices, cultural heritage, and involvement of various stakeholders are emphasized against the background of an aging farming population, rural-urban migration, youth exodus, poor maintenance of farmlands, and transferring traditional and local knowledge. By identifying the drivers of change and understanding the current socioeconomic conditions of the agricultural heritage systems in Japan as portrayed in the GIAHS application proposals, the study has clarified the strengths and challenges of the sustainability of these systems. Based on the analysis, the study proposes a comprehensive set of indicators to be considered when developing the GIAHS proposals and for updating the action plan for monitoring and managing the GIAHS sites. It is expected that the findings and recommended indicators will contribute not only in the improvement of the information integrity of future GIAHS proposals, but also as reference for the development and monitoring of GIAHS conservation action plans.

Keywords: agricultural heritage systems; traditional knowledge; socio-ecological production landscapes and seascapes (SEPLS)

1. Introduction

The Globally Important Agricultural Heritage Systems (GIAHS) was first launched by the Food and Agriculture Organization of the United Nations (FAO) as a Global Partnership Initiative during the World Summit on Sustainable Development in 2002 held in Johannesburg, South Africa to address the sustainable development of family agriculture and traditional farming practices [1]. Officially an FAO Programme from 2016, GIAHS was developed to safeguard traditional agricultural systems of global importance, which harness the harmonious relationship between people and nature.

Defined by FAO 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", GIAHS are also often understood as "outstanding landscapes of aesthetic beauty that combine agricultural biodiversity, resilient ecosystems and a valuable cultural heritage" [2], p.3. Yet, more than landscapes, GIAHS are also diverse and locally adapted agricultural systems, which resulted from centuries of biological and cultural exchanges between humankind and the environment, delivering goods and services from ecosystems and securing the subsistence of small-scale farmers and indigenous communities. The focus of the GIAHS Programme is the dynamic conservation and adaptive management of traditional agricultural systems that sustain livelihoods, promote food security, conserve in situ agrobiodiversity, protect unique and vulnerable landscapes, and preserve traditional knowledge and cultural heritage of local farming communities. GIAHS has started as an initiative with eight pilot sites from six developing countries in 2005 [1]. It was not until 2011 that the GIAHS designation has been extended to developed countries, when Japan received the first two GIAHS designations. It has designated about 59 sites from 22 countries across the globe as of March 2020.

Despite being a developed country, the socio-ecological production landscapes and seascapes (SEPLS), or also commonly referred to as *satoyama* and *satoumi*, are archetypical of rural farming environments in Japan where traditional farming concepts similar to that of GIAHS are being practiced [3]. However, in recent decades, climate change, depletion of natural resources, youth exodus from rural communities and low economic potential have continually threatened the survival of traditional agricultural systems in Japan. These alarming trends may eventually lead to the disappearance of traditional knowledge and ingenuity, as well as the abandonment of these *satoyama* and *satoumi* areas hosting endangered endemic flora and fauna [4]. Embodying the concepts of sustainable development, socio-economic progress, and environmental conservation, GIAHS designations are expected to be useful in overcoming the common challenges faced by both developing and developed countries in ensuring the inheritance of traditional agricultural systems. The conservation of GIAHS requires multi-stakeholder participation in promoting the understanding and importance of the agricultural systems, transfer of traditional knowledge to future generations, boosting the value of local products and commodities, creating opportunities for agro-tourism, and formulating schemes for incentives and market opportunities [5,6].

To be designated as a GIAHS, the proposed agricultural system must be able to explain its global, historical, and contemporary relevance, as well as fulfill five key selection criteria [1,2]. The criteria include (1) food and livelihood security, (2) agro-biodiversity, (3) local and traditional knowledge systems and technologies, (4) cultures, values, and social organizations, and (5) landscapes and seascapes features. In addition to these five criteria, Japan introduced three additional criteria for Japan GIAHS selection in 2015 for a more holistic and comprehensive assessment of GIAHS and the needs in this developed country's context [7]. These criteria are (i) enhanced resilience (ecological), (ii) establishing the new commons (social), and (iii) creating new business models (economic) [8].

While in recent years, GIAHS designations have also been increasing in developed countries, including South Korea, Spain, Italy, and Portugal, Japan currently has the largest number of GIAHS sites in a developed country, with a total of 11 sites, second overall to the developing China with 15 sites. Despite almost two decades of its implementation, FAO has not set any requirements nor given guidance on monitoring the conservation of GIAHS, but leaves it to the discretion of each GIAHS site to conduct voluntary self-evaluation. Understanding the socio-economic background and motivations of Japan's applications to GIAHS and their expected impacts can provide insights on dynamic conservation and sustainable management of traditional agricultural systems, applicable to both developing and developed countries, with or without GIAHS designations. This study thus aims, through examining the GIAHS proposals from Japan, to (1) conduct characteristic analysis to identify elements and perspectives related to the GIAHS selection criteria, (2) understand the motivations and socioeconomic conditions, including challenges and opportunities related to the GIAHS application, so as to (3) propose a set of indicators and perspectives to address these challenges and opportunities for improving the application, monitoring, and management of the GIAHS. It is expected that the findings and recommended indicators will contribute not only to improve on the information integrity of future GIAHS proposals, but also as reference for the development and monitoring of GIAHS conservation action plans.

2. Materials and Methodology

A total of 11 GIAHS proposal documents from Japan (Table 1) were collected, reviewed, and evaluated. These proposals in English were accessed on July 2018 through the FAO website for GIAHS (Globally Important Agricultural Heritage Systems FAO website, http://www.fao.org/giahs/en/). Site codes (e.g., NTO, SDO) were assigned to refer to the GIAHS titles in this study. As shown in Figure 1, GIAHS designations spread across the country, except for the Hokkaido Region on the far north and Okinawa at the furthest south.

Table 1. The 11 Globally Important Agricultural Heritage Systems (GIAHS) sites in Japan as of March 2020.

Year	Title of Systems (Applicant)	Site Code
2011	Noto's Satoyama and Satoumi [9]	NTO
2011	Sado's Satoyama in Harmony with Japanese Crested Ibis [10]	SDO
2013	Managing Aso Grasslands for Sustainable Agriculture [11]	ASO
2013	Traditional Tea-grass Integrated System in Shizuoka [12]	TSH
2013	Kunisaki Peninsula Usa Integrated Forestry, Agriculture and Fisheries System [13]	KUN
2015	Ayu of the Nagara River System [14]	NGR
2015	Minabe-Tanabe Ume System [15]	MNT
2015	Takachihogo-Shiibayama Mountainous Agriculture and Forestry System [16]	TKS
2017	Osaki Kodo's Traditional Water Management System for Sustainable Paddy Agriculture [17]	OSK
2018	Nishi-Awa Steep Slope Land Agriculture System [18]	NSA
2018	Traditional WASABI Cultivation in Shizuoka [19]	WSH

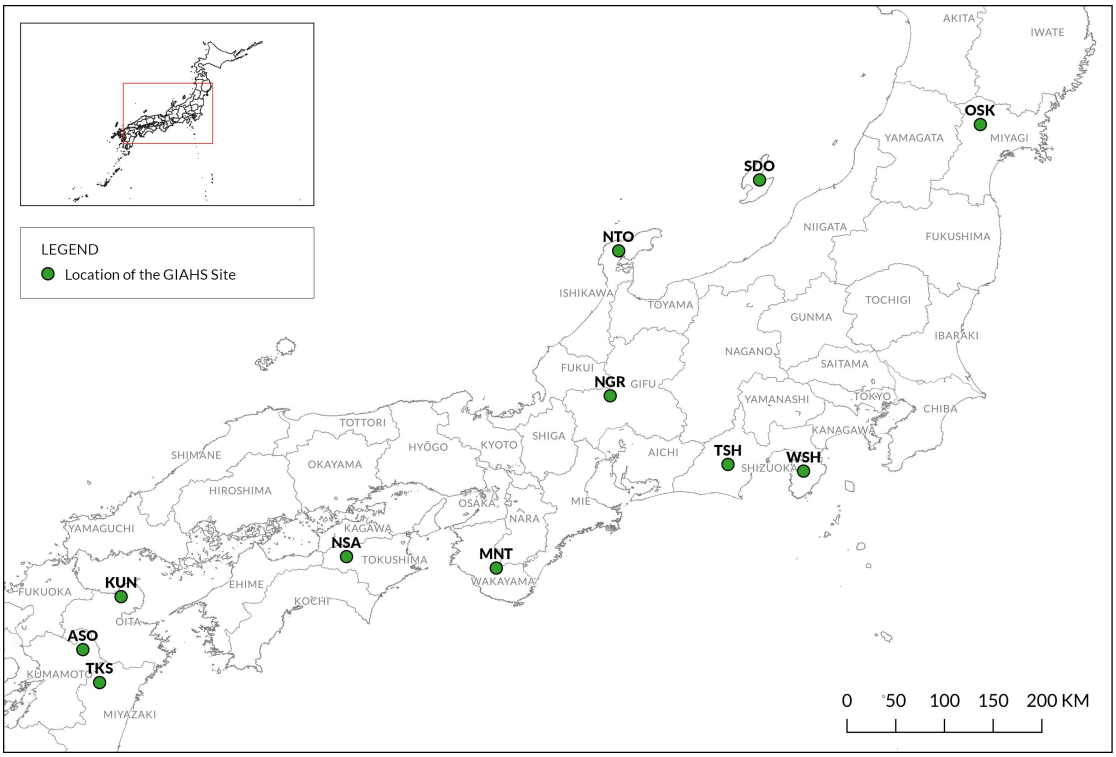

Figure 1. The locations of the GIAHS sites in Japan as of March 2020.

Figure 2 describes the methodological flow of the study, which took the following steps:

1. Gathering the digital copy of all 11 Japan GIAHS proposal documents in English;
2. The information was tabulated under three major categories in a spreadsheet program, namely (i) basic characteristics, (ii) the five GIAHS criteria, and (iii) the three additional Japan GIAHS criteria. This was conducted through a comprehensive review and detailed manual extraction of text information for each proposal, due to the differences found in the proposal documents, especially in writing style and interpretation of each criterion;
3. Information in the preliminary data set that overlapped across criteria or deemed as better fits in the discussion of another criterion was re-classified based on the authors' understanding;
4. Missing, inconsistent, and lacking information was also verified and substantiated with other official sources;
5. The resulting data set, both qualitative and quantitative information, was compared and analyzed for similarities and complementarities across the three major categories aforementioned in Step 2, as well as challenges and opportunities facing the conservation of GIAHS;
6. Literature review journal articles and grey literature on GIAHS and other agricultural landscape conservation were conducted to validate and substantiate the analysis findings;
7. Results of the analysis findings are presented according to the three major categories in Step 2; and
8. Discussion of the study presented the challenges and opportunities of GIAHS conservation, and based on the study findings recommended a set of indicators for monitoring.

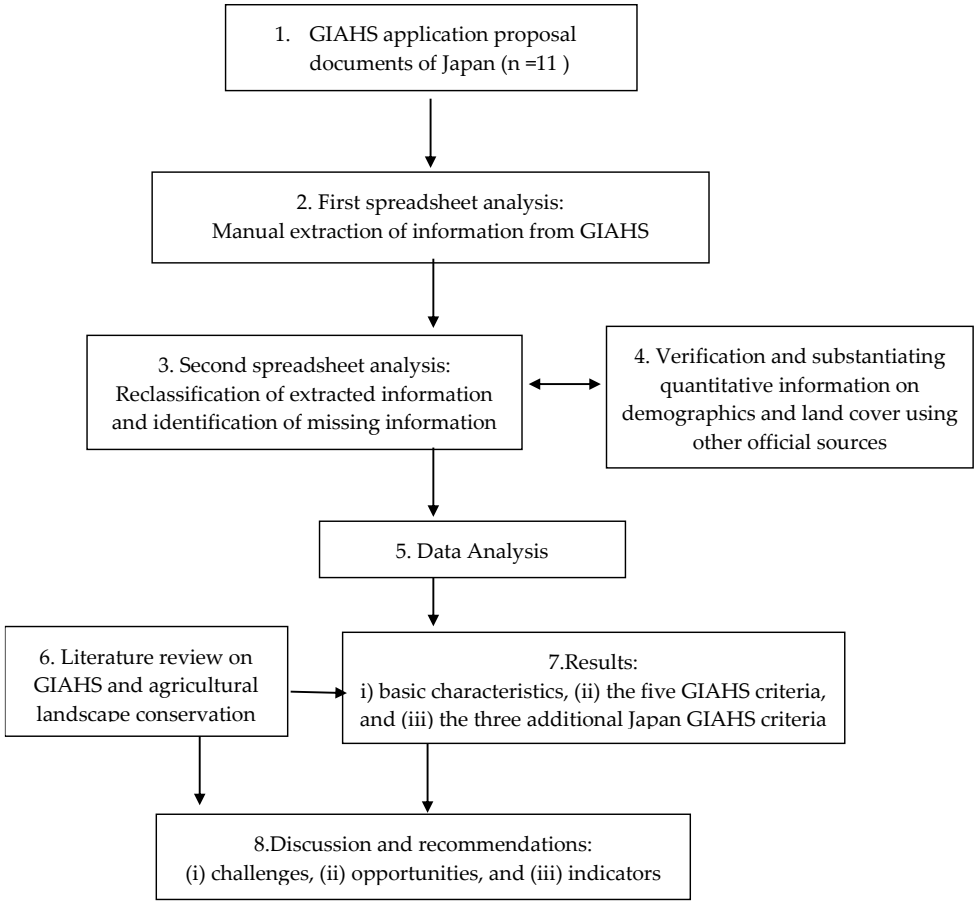

Figure 2. Methodological flow of the study.

Some limitations were found in the inconsistencies of presented data differing across the proposals. For instance, in Step 4, the study had to supplement statistical data by referring to other sources to enable comparative analysis of population and land cover. In most proposals, the population working in the agriculture sector in the GIAHS had to be inferred, so the study derived the figures using the statistics of the 2010 Census of Agriculture and Forestry [20]. The figures in 2010, that were available before the first GIAHS designations in Japan in 2011, were taken to set an equal basis of comparison. The population involved in agriculture was derived from the number of sales farmers mainly engaged in family-operated and custom farming as their main line of livelihood [20,21]. For forestry, available data were limited to the number of business entities rather than the number of individual foresters, which was also taken from the census [20]. As for the total population of the municipalities for each GIAHS, it was retrieved from the 2010 census conducted by the Ministry of Internal Affairs and Communications [22].

Similarly, the land cover and site area provided in the proposals had to be verified with the land cover information downloaded from the Japan Aerospace Exploration Agency (JAXA) Earth Observation Research Center (EORC) website (JAXA EORC website: https://www.eorc.jaxa.jp/ALOS/en/lulc/lulc_index.htm), which was used for calculating the areas of the GIAHS using a geographic information systems (GIS) software. The World Geodetic System of 1984 Universal Transverse Mercator projection with the appropriate zones for the sites was used as the map projection for the computations. The land cover information was then compared with the data on administrative boundaries for Japan obtained from the National Land Numerical Information (MLIT National Land Numerical Information website: http://nlftp.mlit.go.jp/ksj-e/index.html) provided by the Ministry of Land, Infrastructure, Transport and Tourism (MLIT).

It should also be noted that there is an inherent limitation to the information provided for GIAHS criteria related to biodiversity and landscape because FAO revised the GIAHS designation criteria in 2016, which changed Criterion 2 "biodiversity and ecosystems functions" to "agro-biodiversity", and Criterion 5 "remarkable landscapes, land and water resource management features" to "landscape and seascape features". Therefore, there were differences in the information provided for these two criteria among the batch of proposals of GIAHS designated before and after 2017.

3. Results

This section summarizes the result of analysis (characteristics of GIAHS of Japan) according to the three categories: basic characteristics, GIAHS selection criteria by FAO, and Japan GIAHS criteria.

3.1. Basic Characteristics

First, it was found that the geographic features of Japan GIAHS often include only basic descriptions of the surrounding environment. The agro-ecological zones were mainly paddy fields, and the major livelihoods were agriculture and forestry. Information in the proposal was cross-cutting and often duplicated across criteria; most of these repetitions were found in the criteria on food and livelihood security, local and traditional knowledge systems and technologies, and cultures, value systems, and social organizations, suggesting the interconnectedness and interdependency of these criteria. In particular, overlaps often existed with information related to the traditional skills and methods, and management systems, as they were relevant and applicable across criteria. The findings on the basic characteristics of each GIAHS were summarized in Table 2.

Second, our analysis revealed that in Japan GIAHS, core farmers constitute only a modest proportion of the local population, which may suggest that agriculture may not be a key local industry. For the population and farmers (Figure 3), the least populated site was TKS with 27,587 people, the most populated was WSH with 1,857,122 people, and the overall average population was 332,597 people, the median at 177,409 people. When compared with the population of farmers, the average farmer percentage to its population was the least in NGR at 1.2 percent, the most in TKS with 14.7 percent, with an average at 6 percent and the median at 4.7 percent. However, the actual number of farmers might be significantly higher if "self-consumption farming" (persons engaged in farming) are also included. Moreover, it was found that demographic information of the overall population and population working in primary sectors were not standardized across the proposals and not provided in some cases.

Third, the findings revealed that the composition of site area in GIAHS varies and is inconsistent, with some areas including the adjacent watershed and residential zones. For the site area (Figure 4a), it was found that the smallest site was TSH at only 13 km^2, the largest was WSH at 1978 km^2, with an average area of 1230 km^2 and the median at 1406 km^2. Larger sites tended to also include watershed forests when accounting for the site area, such as WSH and NGR, while smaller sites were limited only to the production areas, as seen in TSH and MNT. The GIAHS site area would be dependent on how the concept of its system was defined, which may not necessarily include the watershed areas. It was also unclear if the site area figures indicated included the residential areas or other public spaces, so the study attempted to verify the land cover composition (see results in Section 3.2.5).

Fourth, the findings suggest that GIAHS farmers manage a significantly larger area of GIAHS-related areas (not restricting only to farmlands) than the other non-GIAHS farmers. For the area per core farmers manage (Figure 4b), it was found that again TSH had the smallest area at 0.002 km^2, while NSA farmers had the largest area at 0.479 km^2, with an average area of 0.18 km^2 and the median at 0.125 km^2. Since the national average farmland area per household in 2011 was 0.0202 km^2 [23], GIAHS farmers manage a significantly larger area than the national average.

Table 2. The summary of the basic information for the GIAHS sites in Japan based on the proposals.

Site Code	Action Plan	Region	Prefecture	Agro-Ecological Zone(s)	Geographic Features	Main Livelihoods	Total Population (2010)	Core Persons Mainly Engaged in Farming (2010) (Farmer/ Population in %)	Business Entities Involved in Forestry (2010)
NTO	No	Noto Peninsula	Ishikawa	Temperate rice paddy area	Hilly, mountainous peninsula	1. Agriculture 2. Forestry 3. Fishery	197,141	6851 (3.5%)	1312
SDO	No	Sado Island	Niigata	1. Paddy field zone	Island	1. Agriculture 2. Tourism	62,727	6827 (10.9%)	289
ASO	Yes	Aso Region	Kumamoto	1. Paddy and dry field farming 2. Grassland and forest	Mount Aso, an active volcano with a huge caldera	1. Agriculture 2. Forestry 3. Tourism	67,836	5370 (4.7%)	965
TSH	Yes	Kakegawa and Neighbouring Region	Shizuoka	1. Upland cropping area	Mountainous and hilly, including the sub-montane areas of the Sourhern Alps in Japan	1. Tea production centered agriculture 2. Commerce 3. Industrial businesses	320,773	15,090 (7.9%)	515
KUN	No	Kunisaki Peninsula, Usa Area	Oita	1. Rice paddies 2. Forests	A peninsula with mountain ridges extending radially from the central lava dome, between which rivers flow rapidly and directly, with level grounds spread out in the north-western area	1. Agriculture 2. Forestry 3. Fisheries 4. Manufacturing industries of precision instruments near Oita airport	177,409	10,653 (6.0%)	593

Table 2. *Cont.*

Site Code	Action Plan	Region	Prefecture	Agro-Ecological Zone(s)	Geographic Features	Main Livelihoods	Total Population (2010)	Core Persons Mainly Engaged in Farming (2010) (Farmer/ Population in %)	Business Entities Involved in Forestry (2010)
NGR	Yes	Upper and Central Nagara River	Gifu	1. Inland fisheries 2. Rice paddies 3. Upland crops	Forests, rivers, and the surrounding plains	1. Agriculture 2. Forestry 3. Fisheries 4. Commerce 5. Tourism	571,674	6594 (1.2%)	2,475
MNT	Yes	Kii Peninsula	Wakayama	1. Rice paddies 2. Orchards	Satoyama-type agricultural area with mudstone rudaceous mountainsides, rivers flowing among them, and rice paddies and other fields along the valleys	1. Agriculture 2. Forestry 3. Food manufacturing 4. Tourism	92,589	6613 (7.1%)	796
TKS	Yes	Shiibayama and Takachihogo Region	Miyazaki	1. Paddy field 2. Dry field	Mountains and valleys	1. Agriculture 2. Forestry 3. Tourism	27,587	4056 (14.7%)	1728
OSK	Yes	Osaki Kodo	Miyagi	1. Paddy agriculture	Alluvial plain	1. Agriculture 2. Forestry 3. Industry 4. Commerce	210,789	9081 (4.3%)	312
NSA	Yes	Shikoku Island	Tokushima	1. Mountainous region cropping area	Steep slope land along the northern ridge of the Shikoku Mountains	1. Agriculture 2. Forestry 3. Green tourism	72,925	2936 (4.0%)	2936
WSH	Yes	Shizuoka Wasabi Cultivating Region	Shizuoka	1. Mountainous region with abundant rainfall	Steep mountains, surrounded by the Pacific Ocean Heavy rainfall and plentiful spring water	1. Manufacturing 2. Agriculture 3. Tourism	1,857,122	26,586 (1.4%)	26,586

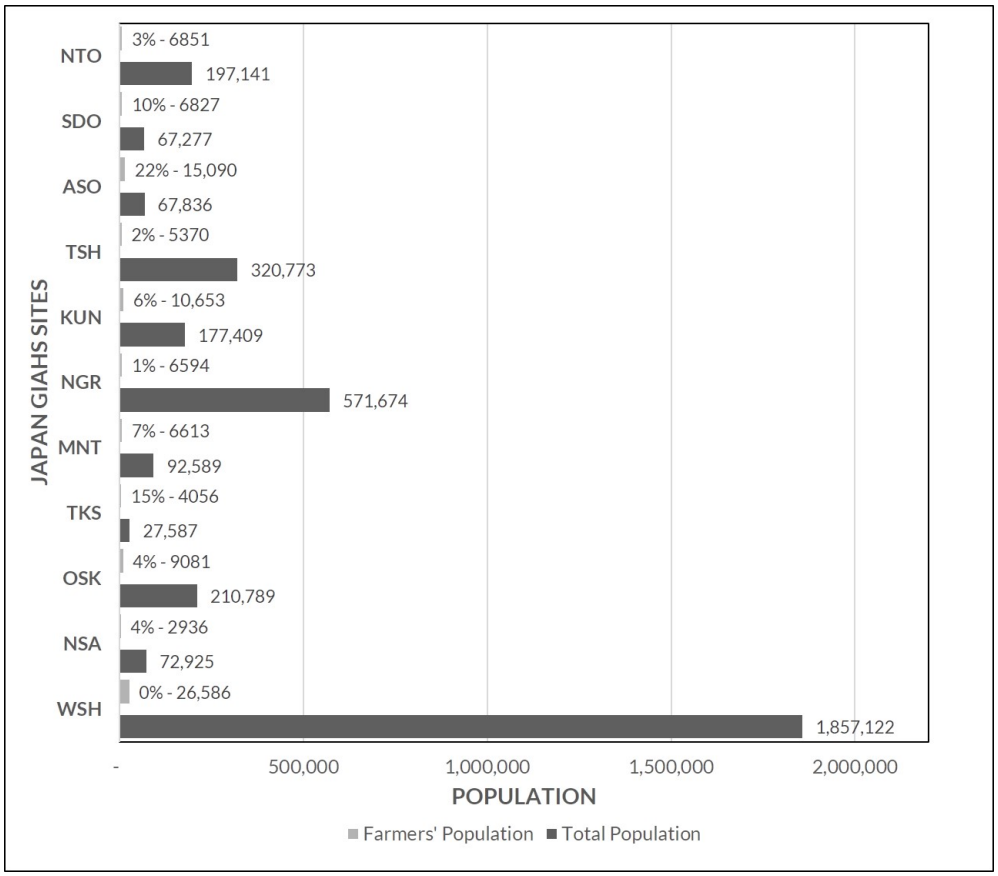

Figure 3. Total population and farmers' population in Japan GIAHS (2010).

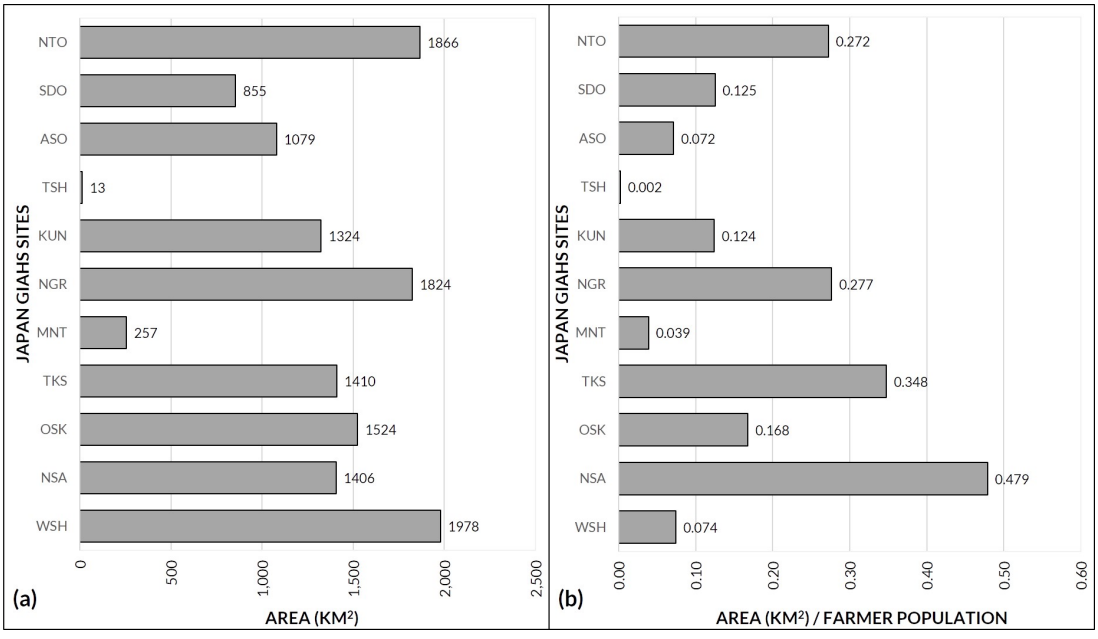

Figure 4. (**a**)The Japan GIAHS site area and (**b**) the site area per core farmer.

Fifth, discrepancies in the reported and actual data were also identified. Upon cross-checking with the Census, it was found that the farming population data significantly differed from the population information provided in some of the proposals, particularly for MNT and WSH. Figures specified in the land area and population (including farming population) were found to be slightly inconsistent due to the use of different units of measure. The site areas indicated in the proposals were compared with

the calculations from the downloaded administrative boundaries, and these areas were found to be equivalent to the sum of the areas of the cities and municipalities encompassing the GIAHS sites, except for MNT and TSH. The analysis of land cover information showed discrepancies in the reported data and would suggest that GIAHS proposals, often drafted by municipalities, merely indicated the area of administrative boundaries but not the actual GIAHS site area. A possible explanation for this might be that municipal officials did not have the relevant expertise to provide actual farming population and land cover data. Also, this finding could be attributed to the ambiguities in defining site land area, and that there were no official guidelines or standards to decide the composition of GIAHS site area. Therefore, it could imply that the reported GIAHS site area could include non-farming areas, in which the relevance to the agricultural system itself, in most cases, would be unexplained.

The above findings may support previous studies that indicate the ambiguity of processes needed to be rectified for GIAHS applications, including the translation and interpretation from the English language and the actual implications [24]. The interpretation of GIAHS criteria is subject to the applicant's understanding and is context-dependent. Also, the translations of GIAHS descriptions to the foreign languages may not capture the exact meaning of each criterion [25]. All GIAHS proposals in this study, except for SDO, were submitted by each of their GIAHS Promotion Associations, that generally consisted of multiple collaborators from several local governments, non-profit organizations (NPOs), universities and research institutions, local communities, cooperatives, and social organizations. This multi-stakeholder collaboration might have, on the contrary, contributed to the simplicity or complexity of the decision-making process through the distribution of responsibilities, which may hinder the development of the GIAHS proposal [24]. Nonetheless, the absence of accurate basic demographic and land area data in Japan GIAHS proposals poses concerns about the accuracy and quality of the information provided. More importantly, it also gives rise to the technical question of whether developing countries can provide such statistical data without capacity-building support, since a developed nation in Japan could not do so.

The disagreement with the data and information found in the proposals helped identify the key challenges in the local governance of GIAHS. It also revealed opportunities to enhance the GIAHS Programme. The requirement for data and consistency of reviewers' expectations when evaluating the GIAHS proposals can be determined from the identified limitations. Also, Japan can further help understand the key challenges in agricultural heritage systems. The review of these proposals also supports the need for more specific guidelines that can improve the consistency of the data, both quantitative and qualitative, to be included in future GIAHS proposals. The research extends the use of this information by listing the potential drivers and proposing a set of recommended indicators that can be used for monitoring the conservation of GIAHS sites. Moreover, the inconsistencies may be due to the lack of quantitative data, such as demographic information including farming population. The analysis was based largely on qualitative information while addressing inconsistencies in quantitative data by using other official sources.

3.2. GIAHS Selection Criteria

3.2.1. Food and Livelihood Security

Under this criterion, the traditional agricultural systems must be economically viable, efficient, resilient, and productive in contributing significantly to the local food supply and securing livelihoods for the farmers. It was found that livelihoods can be divided into either rice-paddy and farmland agriculture dominant type or forestry-based earning, which is further divided into timber or non-timber types. In most of the sites, the combination of both agriculture and forestry formed the main livelihoods, such as NTO, ASO, KUN, MNT, TKS, OSK, NSA, and WSH, while for SDO it was mainly agriculture, NGR it was inland fisheries, and TSH a tea-grass cultivation system.

The descriptions of agriculture under this criterion focused mainly on explaining how agriculture is an important local industry, production system of key crops, employment situation, agricultural output,

and information on related industries such as processed foods and tourism. However, the provided information varies, sometimes incomplete and inconsistent across the proposals.

Only MNT had reported figures to the four basic statistics, namely population, the agricultural work force, types of crops and corresponding yield, and the revenue from these agricultural livelihoods, to determine the economic importance. On the other extreme, NTO had no relevant economic data related to farming but only a rough estimation of total arable area. Although NTO, KUN, and NGR included fisheries in their systems, fisheries volume was not reported. The agricultural income ranged from 0.97 billion JPY (NSA, mainly grains and vegetables) to 31.9 billion JPY (TSH, tea), with a rough estimation of an average of 13 billion JPY per GIAHS (the general average of eight GIAHS, excluding NTO, KUN, and OSK as figures were not available). Only NGR and MNT referred to income from other related industries. Only SDO and NTO, the first two GIAHS designations in 2011, cited self-sufficiency rates of 187% calorie-based for SDO and 383.7% rice for NTO. Thus, consistent and common indicators to measure food and livelihood security should be introduced to enable a systematic statistical comparison of the GIAHS, while allowing flexible customization and localization of such indicators depending on local context (See Section 4.3 for the recommended indicators).

3.2.2. Agro-Biodiversity

Under this criterion, the sites must feature a rich and unique agro-biodiversity in terms of production of a wide variety of crops, conservation of indigenous varieties, cultivar diversity and genetic resources, and diversification of farming practices in forms of polyculture. Agro-biodiversity characterizes the biological diversity associated with food and agriculture, the surrounding and adjacent environments and the knowledge associated with these components [25,26]. As aforementioned, it must be noted that FAO changed the GIAHS criterion of "biodiversity and ecosystem services" to "agro-biodiversity" in 2016. Thus, proposals of GIAHS designated before 2016, i.e., NTO, SDO, ASO, TSH, KUN, NGR, MNT, and TKS, referred to associated biodiversity of the GIAHS in general, while designations after 2016, i.e., OSK, NSA, and WSH, made more specific references to agro-biodiversity, that is, biodiversity directly related and dependent on agriculture.

It was found that the cultivation of *dento-yasai*, or indigenous traditional vegetables, was most frequently cited as an example of agro-biodiversity efforts to conserve genetic resources and local varieties. *Dento-yasai* cultivated in specific regions are important aspects of history and cultural heritage of the local areas and their landscapes [27]. Yet, these traditional crops, defined at the local scale and known by their local names, are often produced in small quantities that are not suitable for major supermarket supply chains. Thus, gradually over time, these traditional vegetables became cultivated mainly for self-consumption and often under traditional farming practices, and conserved in local or family seed banks. Most of the GIAHS proposals mentioned that the designation would give impetus to the conservation of such *dento-yasai* through the revival of food culture associated with these indigenous crops and boosting value-added income. The continual cultivation of such traditional vegetables is made possible by the diverse land uses of small pockets of farmland and ecosystems in *satoyama*.

Central to the conservation of agro-biodiversity and related biodiversity is the *satoyama* concept, a traditional way of life in rural Japan which promotes the balanced co-existence of the local communities and the farming environment, which not only produces a variety of food, but also protects habitats for rare and endangered species of wildlife as well as ensures the well-being of the people. *Satoyama* is a Japanese term referring to socio-ecological production landscapes (SEPLS), which are mosaics of diverse land uses and ecosystems shaped through sustainable human interactions with nature over a long period of time [3,4,28]. One of the most representative examples applying the *satoyama* concept in Japan GIAHS is SDO. The traditional rice cultivation practices in the *satoyama* landscapes of SDO are mosaics of diverse biotopes, which proved to be effective in enhancing habitats for the endangered Japanese Crested Ibis (*Nipponia nippon*), whose survival is critically dependent on this varied landscape for food and shelter.

The agro-biodiversity can be nurtured through traditional practices of farming. For example, endemic and endangered species of flora can be conserved with the sustainable slash-and-burn practices in ASO and TKS and by maintaining semi-grasslands around tea gardens in TSH, where the grass collected is used for mulching purposes. The combination of coppice trees and *ume* (Japanese plum) orchards in MNT provides pollinators with a secure source of nectar throughout the year. Discontinuing the traditional way of farming may also introduce adverse impacts. In some cases, such as in ASO, where the lack of maintenance in the grasslands has led to the invasion of low bushes, negatively changing the biodiversity in the area, traditional practices of slash-and-burn and cattle grazing, though labor-intensive, must continue. Farmers also have a profound understanding of in situ biodiversity and are capable of implementing effective strategies for conservation and recovery. Agricultural heritage systems have supported genetic diversity and preservation of genetic resources as well as the growth of natural and wild medicine [29]. However, most GIAHS also acknowledge that underuse and the lack of maintenance of the traditional management systems due to aging society and depopulation have started to affect the in situ biodiversity.

3.2.3. Local and Traditional Knowledge Systems and Technologies

Under this criterion, the use of extensive traditional and local knowledge of the indigenous people and family farmers on farming practices and techniques, as well as underlying ecological processes and functions within the site, must be described. Knowledge transfer to succeeding generations is also crucial for the inheritance of the GIAHS.

It has been found that local and traditional knowledge systems of the GIAHS in Japan can be broadly classified into (i) landscapes/seascapes systems, (ii) farming practice systems, or (iii) combination of both landscape/seascape system with farming practice. These three models are based on two knowledge systems: either as land/sea use systems or specific techniques on farming, fishing, or related livelihoods. While some of the GIAHS around the world focus mainly on genetic resources, GIAHS in Japan conserve some indigenous varieties but conservation of genetic resources is not the main feature. One such example of GIAHS with the genetic resource as their main feature is Chile's Chiloé Agriculture that conserves through cultivating around 100 native varieties of potatoes [30]. Many of the traditional agricultural practices can be traced back nearly 1000 years ago and with a few sites, such as SDO and ASO. These sites applied modern technology as part of the advancements during the 20th century to improve production efficiency.

Out of the 11 GIAHS, eight systems can be categorized as landscape/seascape systems (SDO, NTO, ASO, KUN, TKS, NGR, MNT and OSK), two are farming practices (TSH and WSH), and one is a combination of both landscape and farming practices (NSA). Five GIAHS are identified as integrated SEPLS, particularly SDO, NTO, KUN, NGR, and MNT, which are traditionally-managed productive landscapes and seascapes. Traditional knowledge also comes in the form of solutions to overcome natural adversity and challenges; mountainous agriculture is practiced in hilly regions of TKS, NSA, and MNT, while OSK, KUN, and WSH feature vast and intricate water management systems. The lack of flat, open areas for farming and soil erosion in TKS, MNT, and TSH is not an obstacle for the farmers and local communities inhabiting the areas. Instead, techniques have been developed to overcome these limitations and thrived. Farming practice-based GIAHS focus on specific traditional practices of farming of a particular crop, like tea for TSH, *wasabi* for WSH, and millet and buckwheat for NSA. All GIAHS sites are also home to a variety of indigenous crops that are exclusively grown in these regions based on traditional and local knowledge.

With the rich traditional and local knowledge, it would be imperative that GIAHS are recognized for their potential as hubs for scientific research contributing to human health and the development of sustainable farming practices [31].

3.2.4. Cultures, Social Organizations, and Value Systems

Under this criterion, the GIAHS are required to demonstrate that cultures, social organizations and values systems are fully integrated in the agricultural systems. The farmers and the local communities are at the center of the operations of the agricultural systems and the co-management of natural resources through communal rules and arrangements. Agriculture-related cultural practices have been closely linked to traditional skills and management systems and define the cultural identities of the local communities. They also incite the individuals' sense of place and values they hold for nature.

Traditional agricultural practices and religious beliefs are closely related, as religion plays an essential role in the traditional agriculture of GIAHS in Japan. Gods and deities are worshipped to pray for abundant harvests, and in return, their gratitude is expressed in an array of local festivals, rituals, and customs. For example, traditional dances to thank the gods for the abundance of harvests, such as the *Noh* (traditional theatre) and *Kagura* (sacred dance rituals) in TKS, NTO, and SDO. The gods are often regarded as custodians of the mountains, water, rivers, and the soils and thus, it is believed that the gods' blessings are crucial for bumper harvests of healthy crops. Farming also originated from religious links, such as in KUN, where agriculture in the area is believed to have started after the long pilgrimage of the Buddhist monk called *Ninmon Bosatsu*, who settled there [5]. Such religious faiths and beliefs then shaped the peoples' values systems towards nature. Many GIAHS sites have tangible and intangible cultural heritages related to the religious practices that have been designated by the local and national government. Three GIAHS sites have also received global recognition, such as the United Nations Educational, Scientific and Cultural Organization (UNESCO) intangible cultural heritage, as shown in Table 3.

Table 3. The tangible and intangible cultural assets and local practices listed in the Japan GIAHS proposals.

Site	Level [2]	Cultural Assets/Local Practices [2]
NTO	G	[a] Oku-noto no Aenokoto (UNESCO Intangible Cultural Heritage of Humanity)
	N	[a] O-kuma Kabuto Matsuri Wakuhata Festival (Important Intangible Cultural Heritage) [a] Amamehagi (Intangible Folk Cultural Asset [e] Mensamanento (Important Intangible Folk Cultural Asset)
	M	[b] Kadomi family (Prefectural Tangible Cultural Asset) [d] Noto-jyofu clothes (Prefectural Intangible Cultural Asset)
	C	[a] Kinko, Seihaku, Mushiokuri, Shinji, and Karatiyama Shinji Sumo [b] 70 temples [d] 8 denominations of agricultural-related crafts [e] Thatched roof construction and restoration and grass-cutting along the irrigation canal edges and reservoirs
SDO	N	[e] Kuruma Rice Planting (Important Intangible Cultural Heritage) [a] Oni-daiko (from Edo period) [a] Hanagasa dance
	C	[a] Rituals and festivals: Noh play
ASO	N	[e] Farming Rituals of Aso (Important Intangible Folk Property)
TSH	C	[a] Tea offering to gods and tea flower arrangement [c] Bracken starch dumpling and kudzu starch cake made from the brakes and kudzu planted in the semi-natural grasslands
KUN	N	[a] Shujo-onie (Important Folk Culture Asset) [b] Usa Hachiman Shrine (National Treasure)
	C	[a] Otaue and Duboruku (Shirahige Shrine) [c] Dango-juri, kenchin-jiru, imokiri, mitori-okowa, and ureshino

Table 3. *Cont.*

Site	Level [2]	Cultural Assets/Local Practices [2]
NGR	G	[d] Honminoshi (UNESCO Intangible Cultural Heritage)
	N	[a] Nagataki En-en Festival Important Intangible Folk Property) [a] Guko Odori (Important Intangible Folk Property) [d] Gujo Honzome Dyeing (Intangible Cultural Heritage) [d] Tools for Cormorant Fishing (Important Tangible Folk Property) [e] Cormorant Fishing in Nagara River (Important Intangible Folk Property)
	C	[b] Nagataki Hakusan shrine and Katsuragake shrine [c] Ayu sushi and hoba sushi
MNT	C	[a] Ume Memorial Service, Ume Day, Mushiokuri, Kiyokawa, Yamamatsuri, and the festival to thank Lord Naotsugu Ando for the promotion of ume [b] Togan shrine, Suga shrine, Gokuraku-ji temple, Sanyari, and Kiyokawatenpo shrine [c] Traditional cuisine and local food Ume culinary cuisine [d] Crafts and tools: Ume dolls
TKS	N	[a] Takachiho No Yokagura (Intangible Folk Cultural Asset) [a] Shiiba Kagura (Intangible Folk Cultural Asset)
	M	[a] Morotsuka Kagura (Prefectural Intangible Folk Cultural Asset)
	C	[a] Shishikake festival, Sasafuri Kagura, Kariboshikiri, Kariboshiki Uta, Utagaki, Hietsuki Bushi, Ita Okoshi, Michiyuki procession [b] Gohei, Takchiho shrine and stone monuments for wet rice cultivation [d] Nishime
OSK	M	[a] Koizumi no Mizushugi (Miyagi Prefecture Intangible Folklore Cultural Asset)
	C	[a] Preliminary celebration rituals, New Year rituals of Konpoji temple, Yanagisawa no Yake-hachiman, Kirigome no Hadaka Kasedon, Mushiokuri, Kappa, Yonekura Kashima Jinja no Kensen Gyoji and Funagatayama worship and other folk beliefs [c] Mochi, fermentation, and freeze-drying for food preservation, sake brewing, rice-based washoku, and gochiso [d] Naruko lacquerware and Naruko Kokeshi wooden dolls [e] Hot spring healing culture Toji
NSA	N	[a] Nishi-Iya Kamishiro-odori Dance (Important Intangible Folk Culture Asset) [b] Ochiai Village (Important Preservation District for Groups of Traditional Buildings)
	C	[a] Rain dance, Nishi-Iya Kamishiro-odori dance, Ichiu Amagoi-odori dance, Oinokosan, Konahiki-bushi, Nihakobi-bushi, Kibiki-uta, and Iya Konahiki-bushi [c] Sun-drying methods of preserving food, potato pits for storage of potatoes, grain-rice cakes, freshwater trout, and vegetables [d] Hitoribiki, sasaba, futaba, tonga, and o-do
WSH	G	[c] Washoku (UNESCO Intangible Cultural Heritage) [1]
	N	[a] Bon Festival (Important Intangible Folk Culture Asset)
	M	[a] Kagura Dancing (Municipal Intangible Folk Culture Asset) [b] Tounji Shrine; Kisobo Water Shrine
	C	[b] Tounji shrine and Kisobo water shrine

[1] Mentioned in WSH, but is not an exclusive designation for the site. [2] Levels: [C] Community, [M] Municipality, [N] National, [G] Global; Taxonomy: [a] rituals, festivals and the arts, [b] shrines, temples and monuments, [c] traditional cuisine and local food, [d] crafts and tools, [e] local knowledge and practices.

The tangible and intangible aspects of cultural heritage listed in the proposals can be classified into the following groups: (a) rituals, festivals, and the arts, (b) shrines, temples, and monuments, (c) traditional cuisine and local food, (d) crafts and tools, and (e) local knowledge and practices. This classification is derived from proposals, which are comprised of the most common terms used by the applicants for identifying different kinds of cultural heritage. Rituals, festivals, and food culture

valued at local levels are mentioned the most, while folk dances and religious monuments are given recognition at the municipal level and above.

Indeed, Japanese cuisine is closely intertwined with the country's agriculture and the GIAHS sites have nurtured their own food culture, specialties, and cooking styles using the farmed products from their traditional agricultural systems. Local and traditional cuisine, in turn, supports the continuity of traditional agriculture and indigenous crops. Some local products are also globally recognized, such as *wasabi* of WSH as an important ingredient to *Washoku* (Japanese cuisine), designated as UNESCO Intangible Cultural Heritage, while others emphasize the importance of local traditional food culture in supporting farming of indigenous crops, such as traditional vegetables of NSA, TKS, and NTO. Apart from consumption use, plants that grow in the GIAHS sites have cultural importance; for example, certain plant species growing in TSH are highly valuable for the Japanese traditional tea ceremony [32].

Social organizations are often community groups formed to co-manage resources such as water and irrigation, grass-cutting, and offering mutual assistance in farming or daily chores. For example, *keiyakukō* in OSK is a social organization that supports the activities of local farming villages, which not only plays a pivotal role in water management, but also offers mutual assistance in agriculture, replacing roofs, weddings, and funerals to local farmers. These local social organizations command high respect from their members, which not only maintains social order and equity within the farming community, but are also critical in shaping community spirit and fostering communal ties. Other examples of social organizations include traditional culinary groups comprising women farmers and residents.

Culture plays a pivotal role in promoting social cohesiveness and unity. It aids in addressing adversities and/or conflicts related to farming. Furthermore, it bonds people spiritually to the land and enables sustainable rural societies. Table 3 lists the various cultural assets and local practices in the Japan GIAHS proposals. This is why GIAHS in Japan are often referred to as "agri-cultural systems", emphasizing that "culture" is embedded and essential in supporting agriculture [33]. In fact, in China, GIAHS is termed in Chinese to literally mean "Globally Important Agricultural Culture Heritage Systems", where agricultural history and culture are taken as core philosophical concepts of Chinese GIAHS [7]. Thus, in closely knitted farming societies in Asia, where farming is often collectively carried out at the village or community level but not in silos, culture and social organizations are essential building blocks for peaceful livelihoods and sustainable use of limited resources, a feature also observed in Japan GIAHS.

3.2.5. Landscape and Seascape Features

Under this criterion, the remarkable landscapes and seascapes created from ingenious land and coastal management systems and technologies should exhibit the results of the generations of traditional practices by farmers with the natural environment and foster resplendent cultural and landscape diversity.

Each land has its unique features, and its landscape today is a reflection of the traditional techniques, social organizations, religion, and agro-biodiversity upon which it is created. By coping with the different land conditions and geographic features, the Japanese GIAHS created unique landscapes and seascapes that are solely maintained because of the long management processes taken by the local communities themselves.

Out of the 11 sites, eight were described as *satoyama*. Expanding on the *satoyama* concept, a couple of proposals also introduced the concepts of *satoumi*, *satokawa* (river following through populated areas), and *satochi* (residential farmlands), referring to coastal seascapes and heterogeneous landscapes in the river systems and land, respectively. Interestingly, it was also observed that such novel Japanese concepts of *satoyama*, *satoumi*, *satochi*, *satokawa,* and *forestopia* are introduced to conceptually illustrate their proposed GIAHS with more cultural meaning. By adding the word *sato*, or village in Japanese, local communities and stakeholders are emphasizing that the sea, river, mountain, and land they live

on are their home, properties, and heritage, and imply that the role of mankind is crucial in maintaining the rural environment.

Looking at the history of the GIAHS designations in Japan, it could be generalized that all GIAHS are based on the SEPLS concepts (Figure 5). From the first two designations of SEPLS (*satoyama* and *satoumi*) systems (NTO and SDO) in 2011, GIAHS designated in 2013 (ASO, TSH and KUN) evolved to emphasize an integrated system of SEPLS (forest-river-land-sea linkages) with the addition of a focus on grassland systems. Then, in 2015, the focus was also placed on mountainous agriculture in underutilized SEPLS, and then, in 2017 to 2018, water management was given importance in SEPLS. Thus, each batch of GIAHS designations occurred to be an extended continuum of the SEPLS concept, which is central and forms the conceptual basis of Japan GIAHS.

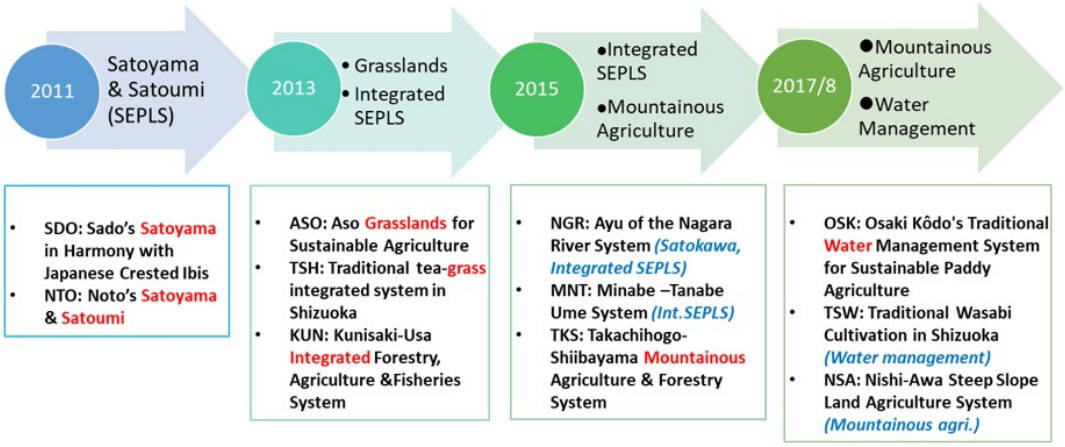

Figure 5. The conceptual development of SEPLS in Japan GIAHS designations.

To understand the land use situation, the land cover composition was verified based on the methodology described in Section 2. The land cover was found to be consistent with the agro-ecological zones that were stated in the proposals (Figure 6).

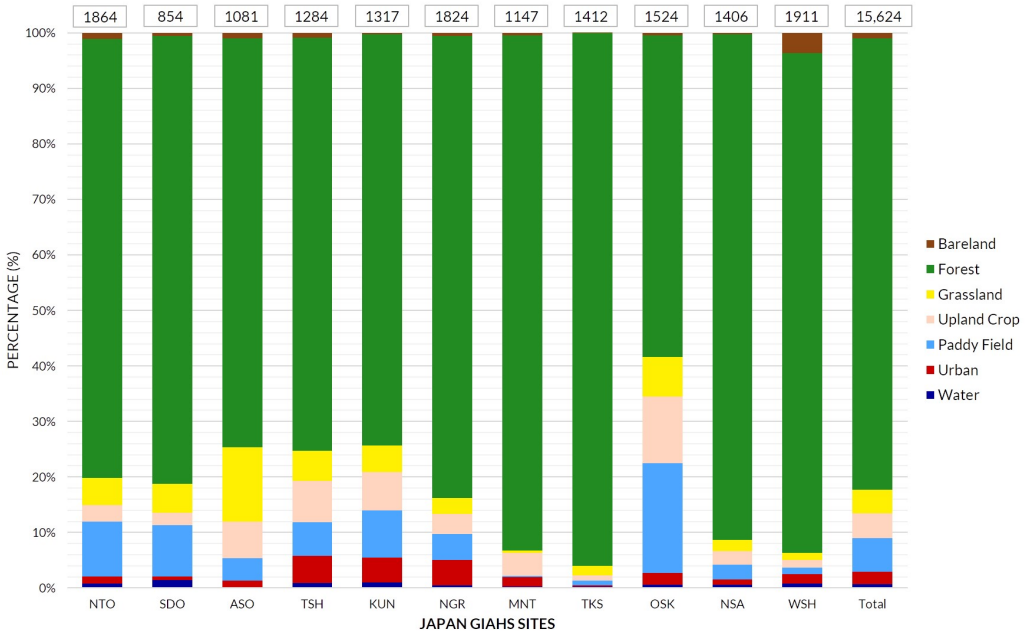

Figure 6. The distribution of the different land cover classes in the GIAHS sites.

Forests dominate the land cover in the GIAHS. Paddy fields comprise significant areas in NTO, SDO, KUN, and OSK sites, verifying the high rice yields for the sites. Grasslands are the most important land cover for ASO and TSH, but are also prevalent in other GIAHS and TSH. TSH maintains one of the few remaining areas of semi-natural grasslands in the country, which has declined from 13% in the beginning of the 20th century to 1% in recent years [32]. TSH also boasts one of the richest biodiversity for semi-natural grasslands in Japan. The high forest cover for TKS supports the joint timber production and *shiitake* mushroom cultivation in the area, and in the case of MNT the forest cover is comprised of coppice forest and *ume* orchards. Urban areas are also included in the declared land area, which comprised residential and commercial areas.

However, the proposals did not state information about the use and management of the seascapes, although NTO, SDO and KUN have seascapes elements in their GIAHS. Thus, proposals should be more specific and clarify the composition of the land cover and the state of land/sea use to be consistent with their declared site area.

3.3. Additional Criteria for the GIAHS Proposals from Japan

Since these three additional domestic criteria of Japan GIAHS introduced after 2014 are only taken into account at the national selection process and are not required for GIAHS proposals submitted to FAO, most proposals omitted direct explanations. Nonetheless, the following sections provide an analysis of the elements described in relation to these three additional criteria, namely resilience, new commons, and new business model.

3.3.1. Resilience

The concept of resilience as a pre-requisite for Japan GIAHS emerged from the understanding that time-tested traditional agricultural practices provide resilient approaches which could mitigate ecological impacts from natural disasters and changing climate [7].

Although the notion of resilience was originally developed in ecology [34], the understanding of resilience tends to embrace different dimensions, including engineering, social, and economic dimensions [35]. Resilience in Japan GIAHS is often described in terms of its resilience towards ecological pressures, mainly natural disasters and climate change. Water management to mitigate the risk of landslides and flooding is often cited as the key solution for addressing disasters, while the diversification of crops through traditional practices of cultivation and growing of traditional varieties is expected to make the GIAHS less susceptible to changing climate in the near future. Resilience is viewed in terms of the ecosystems and functions, such as climate change mitigation, carbon sequestration, prevention of soil erosion, provision of habitats for endemic and endangered species, water purification, food provision, genetic diversity and preservation, pollination, and protection from flooding. Climate change is cited as a major concern in most of the proposals, especially in relation to the intensification of natural disasters and the implications for biodiversity loss. Increasing incidents of flash floods and intensification of typhoons across Japan in recent years also raise concerns about the ecological resilience of the SEPLS against these natural disasters. GIAHS sites are not exempted from these climate change impacts, for instance typhoons in Wakayama brought strong sea winds and a great amount of water, with salt penetrating and destroying *ume* farms in MNT [36]. In the face of the climate change pressures, time-tested indigenous crops cultivated in a traditional manner, such as the Japanese millet cultivated in mountainous Shiiba village of TKS, can be more resilient than conventional crops. In NSA, the custom of sharing harvests amongst farmers of different settlements can distribute the risk of poor harvests resulting from unfavorable weather conditions, illustrating how social resilience can complement ecological and economic resilience. In NTO, such non-market food-sharing practice widely remains not only among farmers, but also between farmers and urban residents [37].

3.3.2. Establishing New Commons

The new commons refers to new ways of co-management system of rural resources, landscape, seascape, and their underlying process of ecosystem structure and functions, which would involve the participation not only of agriculture-related households, but also local governments, businesses, NGOs/NPOs (non-government organizations/non-profit organizations), and urban residents, in the formulation of a new framework for natural resources management [3,38]. This criterion came from the necessity of dealing with the decreasing working population and changing values and lifestyles in the rural areas of Japan [4,7]. In order to pass down and continue the GIAHS to the future generations, multi-stakeholder collaborations among residents from rural and urban areas, national and local government, business entities, research and academic institutions, and NPOs were proposed to co-manage the resources. The Japan GIAHS stakeholders listed in the GIAHS Promotion Associations and cooperating organizations in the proposals and respective actions plans are identified and summarized in Table 4. Stakeholders in the agriculture-related sectors, i.e., agriculture, forestry, and fisheries, are included based on the livelihoods descriptions mentioned in the proposal.

Table 4. Sectors and actors/stakeholders involved in Japan's GIAHS sites.

Site (No. of Stakeholder Types)	Agriculture	Forestry	Fisheries	Municipal Government	Prefectural Government	National Government	Cooperatives	Business Sectors	Community Groups	University/Research Institutions	NGO/NPO
NTO (10)	•	•	•	•	•	•			•	•	•
SDO (7)	•	•		•	•	•	•			•	
ASO (7)	•	•		•	•	•	•				•
SHTTSH (6)	•			•	•	•	•			•	
KUN (7)	•	•	•	•	•	•			•	•	
NGR (8)	•		•	•	•	•	•		•	•	
MNT (9)	•	•		•	•	•	•	•	•	•	
TKS (8)	•	•		•	•	•		•	•	•	
OSK (8)	•			•	•	•	•		•	•	•
NSA (8)	•	•		•	•	•	•		•	•	
WSH (8)	•	•		•	•	•	•		•	•	

All GIAHS involve governments from national, prefectural, and municipal levels, highlighting that the leadership and commitment of governments are essential to ensure coordinated efforts for GIAHS conservation. The management and conservation of GIAHS go beyond farmers and require the collaboration of different actors from various sectors. All Japan GIAHS have each involved more than five stakeholder groups. All GIAHS have an agriculture sector, however, they might not necessarily have the explicit support from cooperatives at the point of GIAHS application. As GIAHS proposals require expertise and information from various fields, i.e., five key criteria, the universities and research institutions have also played an indispensable role in supporting the applications. However, the presence and role of related business sectors are not often explicitly mentioned in the proposals, despite showcasing examples of processed products from farm products and emphasizing how agriculture-related business innovations in GIAHS will boost the local economy.

Other efforts taken to establish new commons include green tourism and volunteer programs. By engaging the younger generation and tourists, farmers and local communities are able to promote

interest and educate individuals about GIAHS while also getting additional hands to work on the farms. Green tourism efforts emerge in the GIAHS sites after designation, such as the "Kunisaki Peninsula Usa GIAHS Long Trail" in KUN. This has been initiated by the local communities and provides tourists with exceptional experiences in agriculture, religion, and culture, which can be a model of sustainable tourism in GIAHS [39]. Extensive educational programs embedded in local schools are also being implemented in some GIAHS, including KUN, MNT, OSK, and WSH, to increase the potential of agriculture as an option for employment of the future generations. The effectiveness of these educational campaigns and capacity building efforts are yet to be realized and may require a consistent scheme of monitoring the GIAHS sites.

3.3.3. New Business Models

New business models in the context for Japan GIAHS are innovative ideas that can help stabilize the rural economy. They are also to maintain the existing agricultural systems to deal with impacts of changing market price, exchange rate, default risks, and other factors affecting the national economy [7].

Traditionally, most Japanese farmers, in particular, small-scale farmers, would sell their produce to the Japan Agricultural Cooperatives (or commonly known as "JA") at prices offered by JA, who would take care of the retailing to wholesale markets around the country. This would mean that the farmers would not be able to set their own prices reflecting at market price unless they find alternative avenues. There was also reluctance from farmers to be innovative, as they see themselves as producers, not as business entities. However, in recent years, to increase the profitability of this declining profession, more farmers had been willing to innovate and be more business-minded in marketing their produce, while taking the opportunity to establish a direct connection with their customers. While JA can only accept items of a certain amount of guaranteed bulk quantity, direct marketing would be especially effective for selling diverse produce in small quantities.

Against this backdrop, Japan's Ministry of Agriculture, Forestry and Fisheries (MAFF) required GIAHS applications to take into account "new business models" that could sustain farming of diverse varieties in small quantities. Apart from direct marketing, proposals mentioned that GIAHS designations could provide the potential of branding and certification of GIAHS products, and other business opportunities, including educational tours and agro-tourism. Branding local products through certifications such as the Regional Collective Trademarks or the Geographical Indicators (GI) and the added value as a GIAHS designated site, had been proven to increase the prices and perceived value of local products, giving local farmers and markets to sell these products with a mark-up of as much as 67% [27,40]. The branding could also ensure food safety and traceability [27]. In several Japan GIAHS, crops were also marketed for their health properties and are often supported by scientific evidence, such as *ume* in MNT, further providing an opportunity for these products to have a positive increase on the sales and impacts on consumer choices. Green tourism had been implemented in several GIAHS sites in Japan, such as *Shunran no Sato*, an organization of farmers in NTO, to sustain the local villages through operating farm inns and participating in traditional agricultural activities [41].

In summary, resilience of GIAHS is often interpreted as ecological and environmental resilience towards climate and biophysical disturbances. However, the concept of resilience goes beyond enhancing ecological engineering and it also includes improving the socio-economic design of how our societies co-exist with nature for the sustainable development of our planet. Nonetheless, this study demonstrates that Japan GIAHS have the socio-economic perspectives covered under the other two additional criteria of new commons (social) and new business models (economic). Hence, in practice, the three additional Japanese characteristics can be, in totality, considered as criteria for the overall resilience of GIAHS, and ultimately ensuring sustainable development of the GIAHS.

4. Discussion and Recommendations

The analysis of 11 Japan GIAHS proposals characterized the important attributes of traditional agricultural systems that determine what Japan views as essential to the sustainability of this heritage. These attributes were also found to be interrelated and interdependent; local food culture sustained the cultivation of traditional crops, and harvests were celebrated over religious rituals and cultural festivals.

However, there are also challenges to address and opportunities that can arise with GIAHS designations, which will be discussed in the first two subsections. Based on the abovementioned findings, the third subsection proposes a set of indicators for the monitoring and evaluation of GIAHS conservation to address these challenges and opportunities. Finally, the last subsection discusses how the GIAHS Programme can be enhanced based on the findings of this research.

4.1. Challenges

SEPLS in Japan have been rapidly declining in the past 50 years [4]. Challenges encountered in these SEPLS are shared in the agricultural heritage systems, including the dependence on imports of agricultural products, rural-urban migration, changes in land use, and abandonment of traditional farming [6,42,43]. It is expected that all GIAHS in Japan face the same pressures, including an aging farming population and depopulation as the younger generation leaves the rural areas to seek better employment and income. With fewer people to take over the family farms and continue the traditional practices, the GIAHS are experiencing a decrease in agricultural production, poor maintenance of farmlands, and the imminent disappearance of traditional techniques. In most GIAHS, some farms have already been abandoned and changes in biodiversity have started to occur, such as the encroachment of wild boars and deer into farmlands. Such prolonged and wide-spread abandonment of agricultural systems can, later on, affect and change the ecological functions and biodiversity, which may in turn lead to the decline in the resilience of the SEPLS.

Henceforth, the key motivation for applying GIAHS can be generalized as the need to deal with adverse ecological, social, and economic impacts on the survival of traditional agricultural systems brought about by the demographic changes. This study finds that the priority is ensuring the continuity of sustainable livelihoods of the local farmers and communities, with a modest degree of interest in conserving biodiversity. For instance, the conservation of agrobiodiversity is driven ultimately for economic outcomes in the form of enhanced branding and marketing of such value-added and eco-friendly products, such as *dento-yasai* in NTO or Japanese Crested Ibis in SDO. A GIAHS designation is expected to increase the significance and value of these traditional agricultural systems that can help boost their livelihoods through opening up economic opportunities to both the local and international markets. The branding of agricultural products discussed in many of the proposals demonstrates the contribution of international designations. Furthermore, this will incentivize local communities to keep these traditional agricultural practices and support initiatives that promote conservation, which include green tourism.

Other challenges clearly demonstrated in the proposals include the passing of the traditional knowledge to future generations and building the capacities of future farmers, given the issues of youth exodus and aging population. Continuation of local knowledge and traditional practices had been considered as the responsibility of the elderly. Most proposals cited education as an important factor in addressing the challenges and threats. It was suggested that education and training can come in the forms of volunteerism, the teaching of the traditional practices in schools and colleges, green tourism, and partnerships. Climate change had also been affecting the sites and can drastically influence the traditional agricultural systems that were created by sustainable livelihoods, social development, and cultural heritage. These threats could also result in the decline of the quality and production of local products, and threaten the sustainability and the future of GIAHS.

4.2. Opportunities

Despite the challenges, the sustainable farming systems of GIAHS also bring opportunities. Agriculture is one of the main contributors to the national economy and sustains humankind [5]. However, in Japan, the Gross Domestic Product (GDP) for agriculture has declined from 3.6 percent in 1980 to 1.2 percent in 2017 and domestic calorie-based food self-sufficiency decreased from 53 percent in 1980 to 38 percent in 2017 [44]. Despite the uptake of mechanization to increase production efficiencies and ease the burden of an aging farmer population, the productivity of modern agriculture is dependent on chemical fertilizers for optimal crop yields, which may not necessarily be sustainable. The GIAHS Programme provides an opportunity to promote traditional farming practices and its contributions to sustainable agriculture and global food security [40]. For example, the traditional species in GIAHS-designated sites are found to be resilient and have a strong resistance to pests and diseases [29]. It is, therefore, necessary to understand agricultural heritage systems as complex adaptive systems, and that the data and insights obtained from GIAHS can contribute to the collective knowledge for small-scale farming around the world [31,45]. Therefore, a robust and dynamic conservation action plan that adequately addresses the challenges can help utilize these opportunities in a strategic and effective manner.

4.3. Recommended Indicators

Based on the above findings, this section lists the identified drivers based on each of the challenges encountered by GIAHS and proposes the following corresponding potential indicators, which can help monitor the impact of the conservation activities for GIAHS (Table 5). These potential indicators have been selected through a combination of existing indicators that are commonly mentioned in the proposals, and newly proposed indicators to address challenges determined by the analysis. This list of potential indicators, however, is neither comprehensive nor exhaustive, and can be modified and re-arranged to reflect the local situation and needs of each GIAHS site. Nonetheless, it is recommended as the minimum set of indicators to consider for a robust GIAHS conservation action plan. These indicators acknowledge GIAHS as complex adaptive systems governed by the human, ecological, and historical dimensions [31].

Table 5. Recommended indicators related to the identified drivers of the key criteria of Japan GIAHS.

Main Criteria	Drivers	Potential Indicators *
Over-arching drivers	• Aging • Depopulation	• **No. of over 65 years old population** • **Population of the youth** • **Rate of population decrease**
Food and Livelihood Security	• Lack of workforce • Reduced production • Abandonment • Dependency on imports • Access and availability of products to consumers	• **Agriculture population** • **Agricultural income** • **Production Volume** • **Income from related industries** - *Land area of production* - *Young and new farmers*
Agro-biodiversity	• Loss of habitat • Loss of traditional species • Change in local biodiversity • Increase in the number of threatened and invasive species	• **No. of threatened species** • **Types of farming practices** - *Types of agro-ecological zones* - *No. of crop varieties* - *No. of indigenous varieties* - *Genetic diversity* - *Reports about invasive species*

Table 5. *Cont.*

Main Criteria	Drivers	Potential Indicators *
Cultures, Value Systems, and Social Organizations	• Inheritance of cultural heritage and value systems • Loss of traditional cuisines	• **Cultural assets and practices taxonomy:** a. Rituals, festivals, and the arts b. Religious places and monuments c. Traditional cuisine and local food d. Crafts and tools e. Local knowledge and practices. • **No. of social organizations supporting GIAHS** - *Research on and activities reinforcing values systems*
Landscapes and Seascapes Features	• Changes in land use • Poor maintenance of land areas and crops	• **Actual GIAHS site boundary and area** • **Land use/land cover change statistics** - *Un-managed/poorly maintained area*
Resilience	• Climate change and disaster pressures	• **Trends in agricultural production or crop yields vis-a-vis annual temperature and precipitation change** - *Ecosystems and watershed management plans* • *(Agro)Ecosystem-based adaptation measures*
New commons	• Lack of policies • Lack of education • Lack of partnerships • Lack of volunteerism • Lack of monitoring	• **Policies and regulations related to agriculture** • **Types of stakeholders** • **Educational and publicity campaigns** • **Volunteer programs** • **Types of partnerships**
New business models	• Need to access wider markets/clientele • Major supply chains do not take diverse, small quantities	• **Branding and certification of agricultural products** • **Developing green and sustainable tourism** - *Channels for direct sales and marketing*

* Indicators in **bold** and in (•) bullets were already used in the reviewed proposals in Japan and may be calculated using existing data. Indicators in *italics* and in (-) bullets are additional/recommended indicators by the authors and may require the collection of new data. It must be noted that the quantification of these indicators, whether existing or new data are required, would depend on the available information in the country.

Since all Japan GIAHS face the common over-arching challenges of aging and depopulation, it is necessary to monitor the demographic trends and change, such as the population of the elderly (over 65 years) and the youth, as well as the rate of population decrease. An increase in the elderly population will signal the need for more assistance, while an increase in youth population (usually aged 15 to 24 years of age defined by the United Nations, but can be adapted to the Japanese standards of below 35 years of age) and slower rate of population can signify the positive impacts on GIAHS designation.

For food security and livelihood, the abandonment of farmlands and reduced production are related to the decreasing number of farmers primarily affected by the lack of interest of the younger generation in farming [29,31,40]. Thus, keeping a statistical record of the agriculture population,

number of young and new farmers, land area of production, production volume, agricultural income, and income from related industries will be essential to monitor the situation of agriculture as a key sector and source of local livelihood. Improving farmers' livelihoods can greatly contribute to the conservation of GIAHS [29].

The changes and decline in agro-biodiversity are characterized by the loss of habitat, loss of traditional species, and the increasing number of endangered and threatened species. There is a need to identify the various types of agro-ecological zones in the GIAHS sites, an inventory of existing crop varieties, including indigenous varieties, and the number of threatened or endangered species in order to identify conservation priorities. It is also important to understand the farming practices that can help improve genetic diversity and identify invasive species that may introduce changes in a site's agro-biodiversity [46]. These indicators can further contribute to understanding the resilience of GIAHS, which is described through its capabilities to buffer unpredictable changes in the environment and preserving the adaptive potential of crops [26].

The loss of local and traditional knowledge systems and technologies follows the lack of interest in inheriting farms and agricultural practices by the younger generation, but it may also be due to the lack of mechanisms that enable the transfer of traditional knowledge. The knowledge of local farmers contributes to agricultural sustainability and resilience because of its holistic, dynamic, and adaptive character, as well as its consideration of the local settings that take into account the social, environmental, economic, empirical, and spiritual factors [31,47]. Introducing comprehensive documentation, increased capacity building and education initiatives and involvement of various stakeholders can help in maintaining and passing the traditional knowledge across generations. GIAHS can serve the purpose of imparting local knowledge to the next generation [39].

For cultures, value systems, and social organizations, it has been found that the inheritance of cultural heritage defines an individual's sense of place, which then fosters the personal or collective attachment to the agricultural heritage systems. Furthermore, culture can be used as a force in the conservation of GIAHS because it influences people's local sense of pride and cultural identities that enable them to consciously protect these landscapes and seascapes [29]. Identifying existing cultural values and systems can help in determining strategies for cooperation. Cultural heritage values must be considered in the greater effort of ensuring global food security, promoting agricultural livelihoods, as well as the implementation of social justice and equity in for environmental sustainability [48]. Such cultural values and systems can be manifested and inculcated through farming related cultural assets and practices, and by social organizations.

Land/sea use change affects the maintenance of landscape and seascape features within the GIAHS. It is crucial to delineate the actual boundaries of the GIAHS sites to map the current land use and land cover to understand the possible driving forces of land use change within the sites. Furthermore, mapping the GIAHS sites properly can provide locations of poorly maintained and abandoned farmlands that can change the landscapes and may eventually lead to farmland collapse [29]. These maps can also help in understanding underuse and invasion of alien species that can affect biodiversity [43]. However, mapping seascapes and understanding the changes in marine ecosystems can be challenging. This will require a high level of expertise to gather, analyze, and visualize information related to seascapes and marine ecosystems. In addition, fishers may avoid identifying or discussing their traditional fishing grounds. If available, maps of benthic cover and relevant ocean parameters as well as details on marine spatial planning and/or marine resources management can also be included, because such information can significantly contribute to understanding the changes in the physical environment of GIAHS.

The history of GIAHS sites has proven its resilience, however, with the increasing pressures from climate change, it will be important to take into account the natural disasters and extreme weather events that affect these areas. Therefore, implementing ecosystems and watershed management plans will be critical to enhance the ecological resilience of the GIAHS. Ecological resilience and the collective effort from the local communities, social organizations, and involvement of various stakeholders define

the resilience of agricultural heritage systems [49]. This resilience demonstrates the interconnectivity of the various criteria that define the GIAHS sites, which enable these sites to buffer disturbance with traditional knowledge, contributed by and disseminated through social organizations and collective actions [47,50]. Agricultural heritage systems make up a significant part of the world's farmlands and have proven their resilience to climate change [49]. Their potential contribution to global food security must be accounted for and further research is needed to ensure the stability and continued resilience of these areas to climate change. In addition, rural landscapes and seascapes can play an essential role to implement ecosystem-based disaster risk reduction and adaptation measures, which has been promoted by many international science and policy communities, including the Intergovernmental Panel on Climate Change (IPCC), Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), United Nations Environment Programme (UNEP), and International Union for Conservation of Nature (IUCN) [51].

The management and maintenance of the new commons are dependent on existing policies, partnerships, and monitoring strategies. The commons host resources for the collective use of the communities and require their engagement and cooperation in order to generate or re-generate the resources provided by the system [52]. In addition, the commons are further supported by partnerships with various stakeholders, volunteers, and capacity-building initiatives. The importance of the involvement of various stakeholders must be recognized in agricultural heritage systems because in reality, the traditional knowledge created in the GIAHS sites is an accumulation of experiential learning, ideas, and information exchange among different actors and contributions from partners and other organizations [25,31,47]. Previous research mentions a consensus on the consideration and inclusion of the conservation of agricultural heritage systems to local socioeconomic development [25].

The GIAHS sites can also provide opportunities in creating new business models that are more accessible by wider markets and more consumers and can promote the branding of local agricultural products. The local knowledge from the agricultural heritage systems plays a crucial role in developing a common interest, a shared vision among stakeholders and business entities, and implementations of new income-generating strategies that can support the GIAHS sites [53]. In addition, green tourism has been an emerging concept that a few of the GIAHS sites have adopted and implemented effectively [5,39,41]. Green tourism promoting GIAHS can further educate the public about the functions of SEPLS and how it contributes to resilience [5].

4.4. Enhancing the FAO GIAHS Programme

The transdisciplinary nature of GIAHS is becoming more relevant than ever in achieving FAO priorities. GIAHS is recognized as contributing to the FAO Strategic Objectives (SO), in particular to SO 2 "Make agriculture, forestry and fisheries more productive and sustainable" [1] (p. 12). The GIAHS Programme supports the United Nations' 2030 Agenda for Sustainable Development and aims to contribute to the Sustainable Development Goals (SDGs, [54]), particularly with high relevance to SDG 1 (no poverty), SDG 2 (zero hunger), SDG 8 (decent work and economic growth), SDG 12 (responsible consumption and production), SDG 13 (climate action), SDG 14 (life below water), and SDG 15 (life on land) [1]. The GIAHS Programme has also been recognized by the Convention on Biological Diversity (CBD) to have very strong links with the CBD Article 10 (c) on the protection and customary use of biological resources through traditional cultural practices that support conservation and sustainability and Article 8 (j) to respect, preserve and maintain knowledge, innovations and practices of indigenous communities embodying traditional lifestyles relevant for the conservation and sustainable use of biological diversity [55]. The conservation of GIAHS demonstrates an integrated model on how multiple values and objectives in environmental governance can be achieved simultaneously.

The local people are key players in delivering these values and global goals. In both developed and developing countries all over the world, farmers and local communities have traditional knowledge, expertise, skills, and practices related to food security, agricultural production, and diversity. While in most GIAHS of developing nations, the local or indigenous communities are mainly responsible for

their agricultural heritage systems, the case of Japan GIAHS has shown that multi-stakeholders from both rural and urban communities can equally provide important contributions toward sustaining food security and continuity of traditional agricultural systems. Shedding light on the challenges of developed societies, such as aging and depopulation issues in Japan, can provide lessons on the future scenarios for GIAHS in other countries to develop more comprehensive conservation action plans. The ambiguities and inconsistencies of information in Japan GIAHS proposals found in this study suggest the need for FAO to give guidance and be more precise on the prerequisites for the GIAHS criteria. The agriculture ministry, which is the clearing house of GIAHS applications for submission to FAO, should also ensure the quality, accuracy, and consistency of the information provided during the domestic selection processes. Currently, there is also no guidance from FAO on how to conduct monitoring and evaluation of GIAHS conservation action plans. The perspectives and indicators proposed in this study could also serve as a reference for FAO to develop guidance on monitoring and evaluation schemes.

5. Conclusions

Based on the analysis, this study proposed a comprehensive set of indicators and perspectives to be considered when developing the GIAHS proposals and for updating the action plans for monitoring and managing the GIAHS sites. By identifying the drivers of change and understanding the current socioeconomic conditions of the agricultural heritage systems in Japan as portrayed in the GIAHS application proposals, this study clarified strengths and challenges of the sustainability of these systems. This study also found inconsistencies in the information provided across the Japan GIAHS proposals, suggesting the need for FAO to provide clearer guidance on the prerequisites of the GIAHS criteria, and for the agriculture ministry to ensure the quality, accuracy and consistency of GIAHS proposals. The findings and recommended indicators from this study could then contribute not only to improve on the information integrity of future GIAHS proposals, but also as reference for the development and monitoring of GIAHS conservation action plans.

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