Citizen Participation in Conservation Activities Enhances Plant Biodiversity in Rice Terraces: A Case Study in Sengamachi-no-Tanada, Kikugawa, Japan

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How to cite this paper: Hidehiro Inagaki. (2021) Citizen Participation in Conservation Activities Enhances Plant Biodiversity in Rice Terraces: A Case Study in Sengamachi-no-Tanada, Kikugawa, Japan. *International Journal of Food Science and Agriculture*, 5(2), 228-232. DOI: 10.26855/ijfsa.2021.06.004

Received: February 26, 2021

Accepted: March 27, 2021

Published: April 20, 2021

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Abstract

The ridges of traditional paddy rice terraces are important for the conservation of plant species diversity. In the present study, the author compared the flora of terraced rice ridges managed by farmers and the flora of ridges managed by citizens, including rice terrace owners (membership area) and volunteers (participant area). There was no difference in the number of plant species per ridge, but the number of plant species and diversity index per area were higher in the membership and participant areas than in the farmers' areas. It is considered this factor is that various mowing by citizens with both machines and traditional sickles produces the same mowing pressure as like the old way before mechanization and contributes to the maintenance of traditional ridge vegetation. In addition, the number of naturalized plants in the membership and participant areas was lower than that in farmers' areas. These results suggested that the participation of people other than farmers in paddy rice terrace ridge management contributes to the maintenance of plant diversity in traditional paddy rice terraces.

Keywords

Rice Terraces, Ridge, Mowing, Biodiversity, Citizen Participation

1. Introduction

Previous studies have indicated that paddy ridges play an important role as habitats for many grassland plants in the current situation in which the number of grassland plants is decreasing due to the decrease in the extent of grassland environments [1-8]. This has been especially evident in recent years, as the traditional vegetation on paddy ridges has disappeared as a consequence of paddy field infrastructure development. The ridges of terraced rice fields, where the native vegetation is maintained, are attracting attention as habitats for grassland plants [1, 3, 9-14]. The floral composition and diversity on paddy ridges depend on ridge management, e.g., mowing, and traditional ridges are maintained by farmers through continuous management [1, 15-20]. However, recently, because of the lack of labor for the maintenance of rice terraces, the opportunities for citizens other than farmers to participate in mowing the ridges have been increasing, as seen in the rice terrace owner system and rice terrace volunteers [15, 21-26].

2. Methods

2.1 Survey area

The survey location was a rice terrace site named Sengamachi-no-tanada, located in Kikugawa City, Japan. The surveyed rice terraces were categorized into three types depending on the management: (1) paddy field areas where economical farming is carried out by two economical farmers (farmers' areas), and two types of paddy field areas managed

by local conservation organizations, including (2) the areas managed by fixed citizens who rent the rice fields (membership areas), and (3) the areas managed by citizens through general participation (participant areas). In the membership area, the owner or local farmer mows the ridges, whereas in the participant areas, the citizens, such as students, family members, and kindergarten children, mow the ridges.

2.2 Vegetation survey

Farmers', membership, and participant areas were each divided into three blocks. In each block, three ridges were randomly selected, and vegetation survey of these ridges was carried out (a total of nine ridges per area). The vegetation survey was conducted on October 2, 2007, using a 0.5-meter square quadrat installed in each ridge. Total dominance (SDR_2) was calculated for each plant species by combining plant height measurements and the Braun-Blanquet cover-abundance scale [27] for the species that appeared in each quadrat. Since the vegetation on the ridges differed between the slope called *Aze* and the part called *Bota*, the latter being located on the rice field side [3], the survey was conducted for each *Bota* and *Aze*. In addition, the Shannon diversity index (H') [28, 29] for each block was calculated using the Braun-Blanquet cover-abundance scale.

3. Results

In the entire survey area, we recorded 45 plant species only in the *Aze* areas of the ridges, 43 plant species only in the *Bota* areas of the ridges, and 60 plant species in both *Aze* and *Bota* areas (data not shown). Figure 1 shows the number of plant species and diversity index in *Aze*. Here, we did not observe a significant difference in the number of plant species per ridge among the farmers', membership, and participant areas (Figure 1A), but when comparing the blocks (i.e., three ridges), the number of plant species was significantly higher in the membership (10.0 species) and participant area (13.7 species) than in the farmers' area (8.8 species) (Figure 1B). In *Aze*, the species diversity index was highest in the participant area, followed by the membership area and the farmers' area (Figure 1B).

A similar tendency as that in *Aze* was observed in *Bota*, as there was no significant difference in the number of plant species per ridge among the three areas (Figure 2 A). In *Bota*, when comparing the blocks, the number of plant species tended to be higher in the membership and participant areas than in the farmers' area, but the difference was not significant (Figure 2B). The diversity indexes in *Bota* were similar to those in *Aze*, being highest in the participant areas, followed by membership area and farmers' areas (Figure 2B).

Figure 1. Number of plant species and Shannon diversity index (H') of *Aze* in the three areas (farmers', membership, and participant). A: One ridge, B: Three ridges. Bars indicate standard deviations. Different lowercase letters indicate significant differences according to Tukey's multiple range test at 5% significance level.

Figure 2. Number of plant species and Shannon diversity index (H') of *Bota* in the three areas (farmers', membership, and participant). A: One ridge, B: Three ridges. Bars indicate standard deviations. Different lowercase letters indicate significant differences according to Tukey's multiple range test at 5% significance level.

Figure 3 shows the species composition in *Bota* and *Aze* of the three areas, with indicated perennials and annuals as well as native and naturalized plant species. In *Aze* of all three areas, the composition rate of native perennial plants was the highest, followed by the composition rate of native annual plants. There were not many naturalized plants in *Aze* of all three areas. Although the species composition was almost the same in the farmers', membership, and participant areas, the composition rate of native perennial plants was slightly lower in the farmers' areas than that in the other two areas. Regarding the species composition in *Bota*, the composition rate of native perennial plants was the highest in membership and participant areas, whereas the composition rate of native annual plants was the highest in farmers' areas. Moreover, the composition rate of naturalized plants was also the highest in farmers' areas.

Figure 3. Composition rate of plant species, including native annual, native perennial, and naturalized perennial species in *Bota* and *Aze* of the three areas (farmers', membership, and participant).

4. Discussion

In the present study, the number of plant species per ridge in *Bota* and *Aze* did not differ among the farmers', membership, and participant areas. In contrast, there were differences in the number of plant species per three ridges among the three areas in *Bota* and *Aze*, i.e., the number of plant species in the membership and participant areas was higher than that in farmers' areas. Kojima et al. [30] reported that there was no difference in the number of observed plant species between ridges managed by farmers and ridges managed by fixed citizens who rents the rice fields. In the present study, although there was little difference between the number of observed plant species per ridge and the diversity index among the three areas, these variables were higher in the membership and participant areas than in farmers' areas. It is well known that the number of plant species in *Bota* and *Aze* is affected by different mowing methods [1, 15, 16, 19]. In our survey area, the mowing season was almost the same in the three areas. Nevertheless, the difference is that various people participate in mowing in the membership and participant areas, whereas the farmers' areas are mowed by a single farmer. It can be presumed that these diverse management practices, including different mowing heights and mowing methods of different people, became a factor influencing plant species diversity in these areas. As it has been pointed that the general biodiversity of ridges depends on their plant species diversity [19, 31], it can be expected that the variety of plant species in the areas where mowing is carried out with the participation of various people has a positive effect on biodiversity in rice terrace fields.

Most plant species in the three areas of the studied rice terrace fields were native. It was reported native plant species are present in traditional ridges [32]. Therefore, we can evaluate that the studied rice terrace fields are still inhabited by healthy traditional plant species. However, naturalized plant species were observed in farmers' areas. Moreover, annual plant species were more common in farmers' areas than in membership and participant areas. Thus, we suggested that there was a higher level of disturbance in the farmers' areas than in the other two areas because it is well known that annual and naturalized plant species tend to grow in places with a high degree of disturbance.

The main difference between ridge management by farmers and citizens is that farmers use mowing machines (shoulder-type hand operated brush cutters), whereas most of citizens use sickles. Mowing with machines is characterized by low mowing height and a high degree of disturbance [33]. In contrast, it has been suggested that mowing by citizens with both machines and traditional sickles produces the same mowing pressure as like the old way before mechanization and contributes to the maintenance of traditional ridge vegetation.

In the present study, the author concluded that participation of people other than farmers in ridge management contributes to the maintenance of plant diversity in traditional paddy rice terraces.

Acknowledgements

This paper supported by JSPS KAKENHI Grant Number JP19K06108.

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