

# The Relationship between Rice Production and Ecosystem Services: Steps toward Sustainable Practices

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## Summary

We human beings always receive ecosystem services from the natural environment. Ecosystem services are now maintained and controlled by human activities. In recent years however, human activities have become so demanding that the ecosystem services are deteriorating to a point at which the natural environment is not conserved. In this paper, we will discuss the relationship between the rice production and ecosystem services taking the example of Miyagi Prefecture in Japan.

Pressures on the natural ecology of paddy fields are reported here, along with steps to improve awareness and restore paddy field ecosystems. These steps include education, wetland conservation, consumer education, and diffusion of reduced-chemical rice production. From 2008, experimental-scale rice production with low agricultural chemicals and chemical fertilizer spread among cooperatives in Miyagi Prefecture. Last year, this trial involved 14 farmers' cooperatives and spread to one third of rice paddies in the prefecture. The goal is to increase to 70% by 2010. Based on rice production to protect the entire local environment, the challenge is to devise the marketing system to protect both producers and the environment. From March, 2009, to appeal to consumers, a unified logo was launched under the brand name "Miyagi Environmentally Sustainable Rice." The increase of environmentally sustainable rice production enables stable sale throughout a year. These concrete steps reverse the trend of loss of ecosystem services in paddy fields.

**Key words** : Ecosystem services, Sustainable agriculture, Rice production,  
Education for sustainable development (E.S.D.)

## 1, Introduction

Ecosystem services are a key term today. In its general definition, this term includes all support for human activities provided by the ecosystem as the source of the environment. The services consist of the landscape of rich green forests, the forest's recharging of the water resource, and the season-by-season provision of safe and rich food. When rice paddies as an ecosystem function to preserve the environment, this raises their ecosystem services. Our lives have substituted artifacts for these kinds of ecosystem services. We have created cities, built an artificial environment, distributed green plants in an artificial way, and tried to manage water flows excessively. Thus, as a rich ecosystem declines, the services created by the ecosystem are not sustained.

In this paper, we will discuss the relationship between rice production, ecosystem services and local activities to preserve rice production, taking the example of Miyagi Prefecture in Japan.

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## 2, The Relationship between Rice and human

### 1) The Relationship between Rice and Rice Paddies

Rice paddies have various functions uniting water, soil and plants. Paddy fields not only preserve ecology but also moderate floods and provide necessary water and nutrients for the growth of rice. In the cool weather, when the *yamase*<sup>1</sup> blows, rice paddies are covered with water to maintain a warm temperature for the rice plants. On hot days, water is circulated to lower the temperature around the plants. The paddies also serve to minimize and ultimately prevent weed growth. It is water that decides the functions of paddies. Water is delivered though rivers and ditches after it is nourished in upstream forests. When the amount of upstream water is not enough, ponds are constructed to conserve water for rice paddies.

Fields themselves are under great pressure toward rationalization. Corresponding to the mechanization of agriculture, "land improvement" projects try to enlarge the size of rice paddies. A formerly large field of 30 ares has now become rather small, while individual paddies are now transformed to 50 ares and 1 hectare. Besides the size, various structures change under rice paddies to manage irrigation and drainage. Figure 1 shows the structure of rice paddies with structural improvement. As underground drains are laid in the paddies, irrigation is separated from drainage. With underground drains, large tractors, rice planting machines, and combine harvesters are able to work in each field. Because imperfectly-drained muddy rice paddies add a large burden to agricultural production, such fields disappear owing to improvement projects. Because paddies without improvement add so many demands to agricultural jobs, it is hard to find farm successors or tenants willing to work them at this time of farmer shortage. These paddies can lie idle under the set-aside policy; they can be abandoned and get out of control. Small paddies along a mountain stream and terraced rice paddies tend to disappear if we do not train people to manage them.

At present, rice paddies with these disadvantaged conditions are put in danger of abandonment by the situation of the low price of rice, the aging of agriculturalists, and the shortage of successors. On the other hand, on advantageous rice paddies, the paddies' ecology is burdened with manageable and simple methods to produce rice. In the process of rice production, a rather troubling work is weeding. My laboratory conducts rice production. Without herbicide, we need to weed wave after wave of Japanese millet and heartshape false pickerelweed by hand or by hoe. Although we think we have weeded, the rice paddy becomes filled with Japanese millet in summer. Through rice production, students learn that weeding is not so easy. Many of the agricultural chemicals used for Tohoku's rice production are herbicides. Essentially, labor shortages increase the use of agricultural chemicals. Furthermore, in terms of fertilizer, Tohoku's rice production has pursued a high yield for decades, and as such depends on chemicals. The issues faced by agricultural producers, such as the low price of rice, the aging

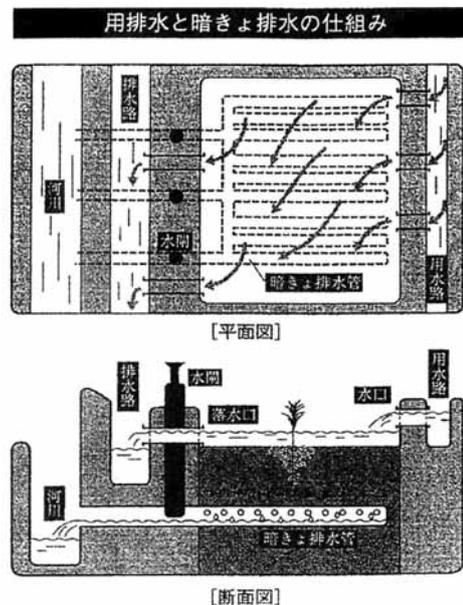


Fig.1. The structure of rice paddies after structural improvement

1 Yamase is a cold north-easterly wind which blows in summer, limiting rice growth.

of agriculturalists, and the shortage of successors increase the dependence on agricultural chemicals including chemical fertilizer and heavily burden paddies' ecology.

Less human labor in the fields leads to neglect of good and bad species in the living environment. Recently, in Miyagi Prefecture, we have seen young black bass in the ditches of rice paddies many times. The supply source of black bass is agricultural ponds. Picture 1 was taken when the students of my laboratory and local residents in Kurihara City, Miyagi Prefecture, cooperated to drain and wash out a pond. When we drained the water and washed out the pond, in addition to large carp and



Pic.1. Students and residents cooperated to drain and wash out a pond.

*funa*<sup>2</sup>, black bass of more than 20 centimeters and lots of fries were found. Mysteriously, we could not find carp and *funa* fries. It appears that they had been eaten by black bass. When we cut open the stomachs of black bass, the black bass fries emerged; black bass ate black bass to grow. The ponds are occupied by invasive fish. The pond had not been washed out for more than a decade. The local community no longer has the resources to wash out their pond, although this used to be a community event every five years.

## 2) Rice Paddies as an Educational Tool

As described above, rice paddies are currently at risk. To reexamine the value of the paddies, education is a starting point, so the next generation can learn about the paddies. Many elementary schools engage in hands-on learning about rice paddies. Hands-on learning of rice planting and harvesting is conducted in schools' paddies and rented paddies around the schools. In autumn, rice-cake making is held as part of a school's harvest festival. Also, in junior high school, outdoor activities and school trips are often used for the program to stay in a farmhouse and practice agricultural jobs.

Mr. Katsunori Onodera at Matsuyama Elementary School of Osaki City has introduced a unique class; rice production is conducted for children to realize how many grains are produced from a single seed. First, the children grow a seedling from a seed. Then, the seedling is planted apart from the other seedlings. The landscape of their rice paddy looks deserted compared with usual paddies; however, about a month later, as a seedling goes through an active tillering stage to multiple stalks, the stalks are grown almost as sound as ones in usual paddies. This method is sparse planting and growing with a seedling to extract the rice's maximum potential for growth. Without herbicide, Mr. Onodera and his students weed by turning a hoeing machine and grazing ducks. The students repeatedly visit their paddy, and observe the growth of rice. The rice blossoms during the summer break. Each student observes the flowers of rice planted individually in plastic bottles. When rice reaches the harvest season, it is dried in the sun.

Picture 2 shows rice sheaves from Mr. Onodera's paddy and those from a full-time farmer lined up. When the students are asked to guess which sheaves they have grown, they immediately point out the smaller ones. However, the correct answer is that it is larger ones which the students grew. Full-time farmers grow rice to a small height as a result of dense planting for efficient machinery use. By this method, the farmers can prevent rice from falling over, or lodging in the field. Thus, the students' agricultural method grows larger rice. By

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2 Funa (Crucian Carp) are a subspecies of carp found in parts of Asia and Europe.

observing the process of growing rice in detail, the students understand the relationship between rice and rice paddies. Teachers and schools are required to find the device to break away from superficial and banal hands-on learning: rice planting, harvesting and rice-cake making.

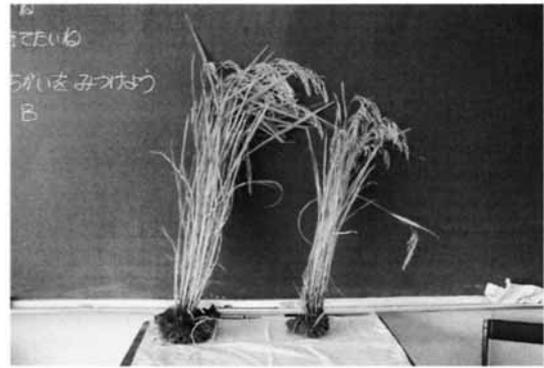
### 3, Protecting Ecology of Rice Paddies to Nurture the Environment

Trials are begun in many ways to minimize the burden on ecology of rice paddy caused by agricultural chemicals and chemical fertilizer. One of them is *fuyumizu tanbo* (winter-flooded rice paddy), begun in Osaki City of Miyagi Prefecture. The Kabukuri and Kejo swamps and their surrounding rice paddies are designated Ramsar wetlands. They are a rich habitat for migrating birds. Annually, more than 100,000 geese, ducks, and swans spend the winter in these wetland areas.

The motto for continuing winter-flooded rice paddies is “Coexistence with Migratory Birds.” The agricultural method is to grow rice without chemicals or chemical fertilizer. The paddies are flooded in winter to feed migratory birds, and in turn the birds’ dung becomes fertilizer. *Tanbo* (the name of a related NPO), has suggested this method of winter-flooded rice paddy to exploit the natural benefits of paddy ecology. Birds’ dung becomes the base to enrich the rice paddies with various microbes and insects such as tubifex worms and bloodworms. According to our experiments, tubifex worms create a layer of organic material (*torotoro*) which prevents the growth of weeds. Microbes make the water of rice paddies get muddy and hinder the sunshine from promoting the growth of weeds. On the paddies, cobwebs spread like lacework to get rid of pests.

These functions of ecology prevent weeds and pests, while also supporting rice production without agricultural chemicals or chemical fertilizer. Shinbo Winter-Flooded Rice Paddy Production Cooperative earned first place in the Competition of Environmentally Sustainable Agriculture in 2007, run by the Ministry of Agriculture, Forestry and Fisheries (MAFF). This cooperative consists of 11 farm households with 22 hectares of rice paddies around the Kabukuri Numa who farm without agricultural chemicals or chemical fertilizer. To confirm the sustainability of ecology, all cooperative members observe the actual ecological condition of their winter-flooded rice paddies. They conduct a biological survey and produce a biological map. Moreover, the ecology of the paddies is opened to elementary and junior high school students to utilize as a tool of environmental education and learning. Of course, farmers act as guides in rice paddy learning. Rice harvested from winter-flooded paddies is sold to local schools for use in lunches. It is also sold in consumer co-ops in the metropolitan area around Tokyo, and in some events to interact with consumers. Furthermore, the Production Cooperative cooperates with a local sake brewery to make Japanese sake using rice from winter-flooded paddies. The sale of rice and sake is used to transmit the information about the sustenance of the paddy ecology to consumers (Picture 3).

The development of a sale, logistics, and marketing system to maintain a price level with which farmers can sustain local agriculture is important to secure various functions and



Pic.2. Rice sheaves grown in Mr. Onodera's paddy and in full-time farmer's. Which one is grown by children?



Pic.3. Rice paddies coexist with migrant birds

ecological service from paddies. This issue is raised in the trials of the Naruko's Rice Project in Onikobe in Miyagi Prefecture, organized by Mr. Tomio Yuki. He promotes *jimotogaku* (local studies) in the Tohoku Region, and continues to study the development of food culture in rural areas.

In mountainous villages, rice paddies are abandoned at a rapid pace and become deserted. Facing this desolate landscape, Mr. Yuki started the Naruko's Rice Project. To explain the objective of the project, Mr. Yuki said, "This is a new trial based on an old experience. To resist the decreasing rice price and agricultural policies to ignore small farmers, producers and consumers directly support each other without dependence on the government. First of all, the most important thing is that we want farmers to be able to produce rice, while feeling secure without discouragement. We raise the farm-gate price of rice from 13,000 yen per 60kg (the current level) to 18,000 yen. This is guaranteed for five years. Then, consumers commit to buy the unit of rice for 24,000 yen. This is completely opposite to the market rule." About this project, Mr. Yuki wrote, "While we want to enlarge the project's support-base, we also want to deepen the understanding of rice, rice paddies, agriculture, and rural lifestyles." Last year, my university asked him to be a part-time instructor. I could not forget students' surprised faces when Mr. Yuki said that 24,000 yen per 60kg (the price of rice to support producers) equals 24 yen per one meal. This is the price of four pieces of Pocky; students' favorite chocolate confectionary.

The Naruko Rice Project suggests one simple and fundamental fact. Rice paddies preserve the environment, which is supported by human beings – i.e. producers and consumers. Only when agricultural producers are supported can the environment and ecology be preserved.

#### **4, Preserving the environment of rice paddies at a regional level**

Recently, in the Tohoku region (including Miyagi Prefecture), concerns about ecological conservation, and environmentally sustainable rice production are growing. Support for environmentally sustainable farmers is rapidly spreading. At the same time, organic agriculture and rice production without pesticides or chemical fertilizer are increasing in some areas. However, environmentally sustainable rice production is not achievable through organic rice production alone. Rather, trials are also leading to the spread of more environmentally sustainable agriculture among conventional farmers. These trials spread the spatial extent of methods using lower agricultural chemicals and less chemical fertilizer to many farmers. Consumers can easily prefer organic rice production and other unique kinds of the production if they exist inside a region with agricultural methods of low agricultural chemicals and chemical fertilizer. As environmentally sustainable agriculture expands to a certain spatial extent, consumers think highly of producers' attempt. Fundamental framework for logistics which support producers' sustainable rice-production and farming is starting to take shape.

Such a trial, the experiment of "environmentally sustainable rice production" started in 1996 as a project of *Kahoku Shimpo*, a local newspaper. For two years, the paper reported this experiment to see if it was possible to produce rice at a commercially competitive level with reduced agricultural chemicals and chemical fertilizer. Participant farmers reported reduced health damage to themselves as producers and reduced costs for agricultural chemicals. Above all, farmers said they were no longer dependent on a manual but were able to think of rice production by themselves. From 1998, this attempt became independent of the newspaper as a citizen organization named the Environmentally Sustainable Rice Network (ESRN). It started the original certification of environmentally sustainable rice production which meant half the use of agricultural chemicals and chemical fertilizer. In 2001, the network became an NPO. Later, ESRN became a registered organization of JAS organic products and while functioning as a certifier for farming without pesticides and chemical fertilizer, also made promoted more environmentally sustainable agriculture among all producers.

Still at this stage, ESRN was merely creating environmentally friendly producers at individual level. The turning point was in 2004 when JA Miyagi Tome in northern Miyagi Prefecture decided to start environmentally sustainable agriculture at the farm coop level. To reduce the number of chemical elements in agriculture, warm water sterilization was introduced to sterilize seed paddy. Many fungicides can be used in this process. The traditional way to sterilize seed rice was with warm water of 60 degree Celsius. This successfully decreased the number of agricultural chemicals to half compared with that in common practice. Currently, 8,000 hectares, or 80% of the 10,000 hectares of the rice paddies in the JA Miyagi Tome area, are devoted to rice production with low agricultural chemicals and chemical fertilizer. Figure 2 shows the prevalence of environmentally sustainable rice. Quite simply, environmentally sustainable rice production is spread from a point to a spatial extent.

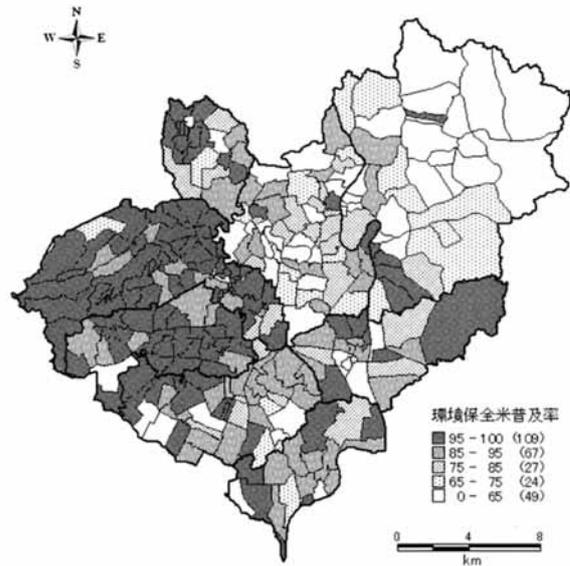


Fig.2. The prevalence of environmentally sustainable rice (the area of each production style/cultivable land) Produced by the NPO Environmentally Sustainable Rice Network. Source: Rice Department, JA Miyagi Tome

To understand the biological impact of environmentally sustainable rice production methods, 14,000 producers answered a survey questionnaire in 2008 and 4,000 answered in 2007). This survey simply asked whether ten kinds of living creatures were present in large number or not. According to the results of surveys in 2007 and 2008, in the systems of production with low agricultural chemicals and chemical fertilizer to the production with no agricultural chemical and chemical fertilizer, the number of creatures increased (Figure 3). Besides, the data from JA Miyagi Tome is comparable between two years. From 2008, this trial spread among cooperatives in

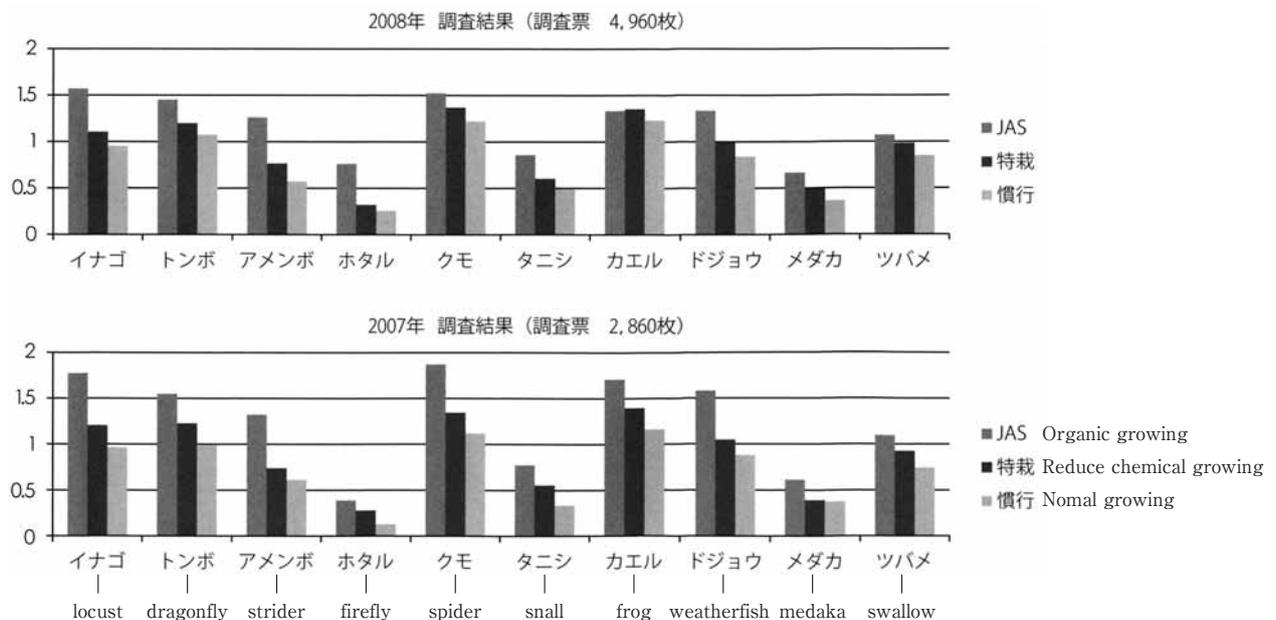


Fig.3. Increasing the number of creature

Miyagi Prefecture. Last year, this trial involved 14 farmers' cooperatives and spread to one third of rice paddies in the prefecture. This continues with the goal to increase the area to 70% of all rice fields by 2010. Given feasible rice production to protect the entire local environment, the next challenge is to devise a marketing system to protect producers and the environment. From March, 2009, to appeal to consumers, a unified logo was adopted under the brand name "Miyagi Environmentally Sustainable Rice." The increase of environmentally sustainable rice production enables the stable sale throughout a year. In Sendai Station, a lunch box of Miyagi's environmentally sustainable rice is now available.

## 5, Conclusion

The creation of a framework to sustain producers is essential to preserve rice paddies which are the provider of ecosystem services, especially under current climate surrounding rice farming – a low rice price, the aging of leading farmers, and the shortage of farm successors. Needless to say, the relations must be created with the definitive support of consumers. This paper introduces the trials toward a framework to support rice paddies in Miyagi Prefecture. We are integrating various regional trials with prefecture-wide movements and the creating opportunities to link children with the elderly to understand the function of rice paddies and to protection of the regional environment.

We are introducing active steps to spread rice production with low agricultural chemicals and chemical fertilizer. These activities have some issues that need to be addressed in order to establish to be sustainable. The first is to build the marketing system to support the price of rice to maintain reproduction for farmers. The second is to build an information system for consumers to understand the value of sustainable rice. The third is to develop ESD for schools to teach the meaning of Ecosystem Services. Without these, the recovery of ecosystem services and the future of the rice farming in Japan look precarious.

## Note

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## 米生産と生態系サービス

小金澤 孝 昭

### 要 旨

人間は、常に自然環境から生態系サービス(供給、調整、文化、基盤サービス)を受けてきた。生態系サービスは、現在人間活動によって維持・管理されている。しかし、人間活動は生態系サービスを過度に使いすぎたり、代替物による生態系サービス利用の放棄を行って、自然環境に負荷を与えている。本論文では、宮城県を事例にして米生産と生態系サービスの関係を明らかにしていきたい。

ここで取りあげた水田の生態系への負荷は、様々な改善方策による現在復元されつつある。改善方策としては、学校教育での食育や水田生態系の改善、消費者への生物多様性の理解向上、減農薬・減化学肥料水稻栽培の普及などがある。2008年から、宮城県では14の農業協同組合が参加して、全県的に減農薬・減化学肥料水稻栽培に取り組んでおり、現在県内の40%の水田面積まで拡大し、2010年には70%を目標にしている。地域の環境をまるごと保全して、生態系サービスを豊かにするためには、生産者が環境保全農業を継続できる流通システム(価格制度)が必要となる。2009年から、みやぎの環境保全米というブランドで、全県的な環境保全農業を推進している。この取り組みを通じて、水田の持つ多面的な生態系サービスを生産者も消費者も享受できる。