Market internalized value of bio-friendly agriculture:
An evaluation of impact of stork-friendly rice production on a local economy

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Abstract

Although there are many studies on evaluating ecosystem services in recent years, most of the studies focus on the externality of ecosystem services. Fundamentally, it is important to understand market internalized value of ecosystem services, but studies on this point of view are rare as far as the author knows.

This study evaluates the impacts on the local economy, as an internalized value of ecosystem services, caused by shifting from conventional to bio-friendly rice farming, using a case study of stork-friendly rice farming (to help conserve white storks) in Toyooka, Japan. After applying an input-output analysis, we consider whether stork-friendly rice farming created a net positive economic impact on the local economy.

The results shows that changing from conventional to stork-friendly rice faming had a high induced effect and that shifting to stork-friendly rice faming creates a net positive economic impact on the local economy.

Keywords

Bio-friendly agriculture, Biodiversity, Ecosystem service, Internalized value, Input-output analysis

JEL codes: Q13, Q51, Q57, R15

1. Introduction

In recent years, the conservation of biodiversity has become an increasingly important issue in agricultural policy, which has led to the implementation of some agricultural practices for conserving biodiversity (bio-friendly farming). Although Sandhu et al. (2012) alerts that the role of ecosystem services in agro-ecosystems is often poorly understood by those in agricultural production, farmers in some regions are trying to boost added value by producing bio-friendly agricultural products. This premium is reflected in the prices of the products, which means it is already incorporated in market value of the products, and regarded as internalized value of ecosystem services. Many studies have evaluated the value of ecosystem cervices not only in agricultural field but also all kinds of ecosystem services and biodiversity so far, particularly after the publication of the Economics of Ecosystem and Biodiversity (TEEB) report in 2010 (Costanza et al., 1997, Loomis et al, 2000, Sagoff, 2011, Kontogianni et al. 2011, Costanza et al., 2014), but most of these studies focus on the externality of ecosystem services. Some part of the value has already accounted in the market value of products but this internalized value is often neglected in ongoing debates.

In addition, practices of bio-friendly farming have various impacts not only on biodiversity and ecosystem services, but also on a local economy. That being said, bio-friendly agricultural production has both negative and positive impacts on the economy. Since these practices tend toward lower-input production in terms of reducing of fertilizers and pesticides, they cause a negative impact on the economy. On the other hand, some practices are trying to use more local inputs for production, and self-sufficient raw material procurement yields a positive impact on the local economy. It is important for agro-ecosystem conservation policies to understand internalized value of ecosystem services and which impact on the local economy is larger: the negative or the positive.

The purpose of this study is to evaluate the impacts on the local economy, as an internalized value of ecosystem services, caused by shifting from conventional rice farming to bio-friendly one, using a case study of bio-friendly rice farming to help conserve white storks in Toyooka, Japan. After applying an input-output (IO) analysis, we consider whether stork-friendly rice farming created a net positive economic impact on the local economy.

2. Stork-friendly farming and local environmental policies in Toyooka

Toyooka is located in western Japan about 150 km away from Kyoto and Osaka (Figure 1). In the past, many white storks lived around Toyooka, but due to the conversion of wetlands into crop land to increase food production after World War II, fields were dried and disconnected from nearby rivers. This resulted in reducing the number of species living in the fields, while the heavy use chemicals killed even more. With less to feed on, white stork numbers plummeted, and the birds eventually went extinct in 1971. Before the extinction, however, the local government launched a conservation project to begin captive breeding of white storks in 1965. By breeding domestic birds with young white storks donated by the Soviet Union, the number of white storks in captivity gradually increased. As of October 2014, 95 birds are raised in the captive facility. In 2005, some white storks were released experimentally, and 84 white storks are now living in the wild habitat around Toyooka and other areas.

In Toyooka, some farmers have been using bio-friendly practices to produce rice since 2003. These methods serve to reduce the input of pesticides and chemical fertilizers, thereby increasing the amount of feed for white storks. This is called stork-friendly farming, and its required and optional elements are shown in Table 1. There are two types of stork-friendly rice: chemical-free and reduced chemical. The former requires no use of chemicals and the latter requires a 75% reduction of chemicals during the cultivation period. The area of stork-friendly farming has risen sharply since 2005 when white storks were released experimentally (Figure 2). Although chemical-free stork-friendly rice is more labor-intensive, it has been dominating a certain share out of all stork friendly rice. The local agricultural cooperative (JA Tajima) sells stork-friendly rice as a higher value-added product than conventional rice. The price of reduced chemical rice is 30% higher than conventional one, and chemical-free has a 70% higher price tag. In addition, although the price of conventional rice is declining recently, the price of stork friendly rice is relatively stable, especially the price of chemical-free is slightly increasing.

3. Review of previous studies

There are many previous studies that evaluate the value of ecosystem services and biodiversity. Nijkamp et al. (2008) provides what elements we should consider when valuing ecosystem services, and Polasky (2009) points out what should be done before evaluating the economic value of biodiversity and ecosystem services. Kassar and Lasserre (2004) evaluate biodiversity considering irreversibility and the future uncertainty of biodiversity using a real option analysis. Also, there are many case studies on biodiversity evaluation like Do and Bennett (2008), Lindehjem and Tuan (2012), and Williams et al. (1997). Do and Bennett (2008) evaluate biodiversity value in Vietnam's Mekong river delta, and Lindehjem and Tuan (2012) evaluate species and nature conservation in Asia and Oceania applying meta-analysis. On a larger scale, Williams et al. (1997) compile a map of biodiversity value worldwide. In Japan, there are some studies that evaluate the value of local biodiversity include Terawaki (1998) and Shimbo (2007). Among them, Kuriyama (1998) covers the basic theory of the contingent valuation method (CVM) and its application to biodiversity evaluation. With regards to agriculture, the relation between agricultural practices and ecosystem services is analyzed by such studies as Broch et al. (2012), Posthumas et al. (2010), Sandhu et al. (2012). Brosh et al. (2012) investigate farmers' willingness to participate in afforestation contracts using a choice experiment of various contracts with the purpose to provide, and Posthumas et al. (2010) explore changes in rural land use in floodplains by measuring the range of ecosystem services provided under different management scenarios. Sandhu et al. (2012) develop a conceptual framework and consult with agro-industry experts to identify the impacts of different agricultural practices on ecosystem services. However, most of these studies are mainly focus on the externalities of ecosystem services, and the value which is already reflected in the market is overlooked.

If one wants to evaluate internalized value of ecosystem services, hedonic pricing method (HPM) ant travel cost method (TCM) are applicable. HPM estimates the implicit price for environmental attributes through the individuals choices for market goods which incorporate such attributes e.g. estimate implicit price for air quality in the price of a house (Maudureira et al., 2007 p7), and TCM estimates the demand for a recreational site using travels costs as a proxy to the individual price for visiting the site. These methods can be regarded that the value of ecosystem services are implicitly internalized in market price. Some previous studies applied HPM (Amrusch and Feilmayr, 2009, Costanza et al., 2006, Ready et al., 1997) and TCM (Baylis, 2002, Hansen, 1999) to assess the value of ecosystem services. However, these methods are categorized as methodologies to estimate non-market value of ecosystem services. If the value of ecosystem services can be more explicitly observed, we can apply more convenient methods. In the case of Toyooka, we can identify the premium of stork-friendly rice by comparing the price of stork-friendly rice with that of conventional, and this premium can be regarded as the value of ecosystem services, we believe that it is not necessary to apply non-market methodologies.

If we narrow the focus to agro-ecosystem conservation in Japan, there have not been so many studies aiming to evaluate the value (both external and internal) of bio-friendly farming practices. Most of studies are focus on the multifunctionality of agriculture (Aizaki et al., 2010, Imaizumi et al., 2006, Ohe, 2011). Nonetheless, in Toyooka, there are two studies that evaluate the economic impact of such practices: one is Sekiya (2009) and the other is Onuma and Yamamoto (2009). Sekiya (2009) uses IO analysis to estimate the induced economic impact of stork-friendly farming in Hyogo Prefecture based on production cost and the number of stork branded products. Sekiya (2009) concludes that the economic impact is very minor and that it is necessary to promote the use of more local materials for stork-friendly products as well as to develop the stork brand in food markets. Sekiya's study is very interesting because of its pioneering evaluation of the economic impact of stork-friendly products. That being said, the study only evaluates impact based on the production cost of stork-friendly farming, not on the conversion from conventional to stork-friendly farming; no consideration is given to the conversion of cropping. In addition, since the boundary of the study's evaluation is all of Hyogo prefecture, it cannot provide an evaluation of the more local impact on Toyooka, which is more important for local policymakers.

Another study, Onuma and Yamamoto (2009), calculates the economic impact of stork-related projects, such as eco-tourism and stork-friendly farming, on Toyooka's economy. They calculate the impacts on eco-tourism and related construction and on the construction of eco-friendly farming infrastructure such as fish-ways and safe refuge areas in paddies. In their evaluation of stork-friendly faming, they analyze both micro-level (farm level) and macro-level (local municipality level) impact. They determine that when a farmer's imputed wage is less than 759 yen per hour, the benefits of stork-friendly farming exceeds those of conventional famers, and thus conclude that both environmental conservation and positive economic impacts are achieved at the micro level. In their local level analysis, their results show that the impact amounts to 1 billion yen from eco-tourism and 8 billion yen from construction of facilities, and they calculate the economic impact on Toyooka's economy using IO analysis. This study is also very interesting because it addresses the impact on Toyooka's economy, but as for the impact on stork-friendly farming, it only addresses with the micro-level impact and does not consider the macro-level impact of the conversion of cropping. Therefore, in this study, we evaluate the economic impact of the shift from conventional to stork-friendly rice farming on Toyooka's economy using IO analysis.

4. Modification of the IO table

In this study, we apply the IO table for Toyooka for the year 2005. The Toyooka city government compiled 36-sector IO tables for the years 2000 and 2005, both of which were published in 2009. Although the tables are very useful for analyzing the local economy, the agricultural sector is not disaggregated into subsectors such as rice and livestock breeding, nor does it disaggregate into stork-friendly cropping and conventional cropping, making it difficult to analyze the impact of the conversion from conventional to stork-friendly cropping without some modification. Therefore, for this analysis, we disaggregated the agricultural sector into three subsectors, conventional rice, stork-friendly rice, and, and compiled a 38-sector IO table (Figure 3).

First, we estimated the production value of each sector, and then subdivided agricultural sector into three: stork-friendly rice, conventional rice, and miscellaneous agriculture (Figure 3). To estimate the production value of each sector, we referred to the cropping areas of stork-friendly rice and of all rice. Since the cropping area of stork-friendly rice was 41.7 hectares in 2005, we multiplied the area by yield per hectare and the farm gate price of stork-friendly rice to estimate production value of the stork-friendly rice sector, which amounted to 52.2 million yen (Table 2). According to census survey data of agriculture, total rice production in Toyooka was 3.99 billion yen in 2005, so the production value of the conventional rice sector was estimated by subtracting 52.2 million from 3.99 billion, leaving 3.938 billion yen. Furthermore, given that total agriculture production was 9.915 billion yen in the original IO table, the production value of miscellaneous agriculture was calculated at 5.925 billion yen.

Secondly, we disaggregated the agricultural sector into three subsectors: stork-friendly rice, conventional rice and miscellaneous agriculture (Figure 3). This was a two-step process. First, we disaggregated rice from agriculture and then subdivided rice into two subsectors. To implement the second step, we had to compile input structures for two rice sectors, which refers to the extent to which these two sectors use inputs produced by the others. We assumed that intermediate inputs for rice production in Toyooka were the same as that for all of Japan and used the input coefficients from the national IO table. We think this is a valid assumption because the rice cropping system of Toyooka does not differ very much from the national one. The input into the rice sector from sector *i*, here denoted as x_{iR}, can be formulated as follows,

$$x_{iR} = a_{iR} \cdot X_R \qquad (1)$$

where, a_{iR} is the national input coefficient for sector *i* in the rice sector, and X_R is the production value of the rice sector in Toyooka. Using this calculation method, we estimated the input into rice sector. Then, we subtracted x_{iR} from the input value for all agriculture to estimate the input into miscellaneous agriculture. Using data on production cost per unit of cropping area, which was provided by the Toyooka Agricultural Extension Center, we estimated the production cost for stork-friendly rice. Since the data is classified into three types of rice—two types of stork-friendly rice (chemical-free and reduced-chemical) and conventional rice— we multiplied the areas of rice cropping for each type to estimate the total production cost. Each cost item was compared with sector definitions from the IO table to determine the estimated shares of stork-friendly rice and conventional one (Table 3).

By multiplying these shares and the inputs into the rice sector from other sectors, we were able to distribute input values between stork-friendly rice and conventional one (Equations (2) and (3)); however, since inputs from sectors which are not indicated in Table 2, such as service and transportation, cannot be estimated from production cost data, we assumed that the inputs per total production value were the same for both stork-friendly rice and conventional one and distributed the input values by using the share of total production values for each type rice (Equations (4) and (5)).

$$x_{iH} = x_{iR} \cdot b_{iH} \qquad (2)$$

$$x_{iC} = x_{iR} \cdot b_{iC} \qquad (3)$$

x_{iH} , x_{iC} : Input into stork-friendly rice or conventional rice from sector *i*

b_{iH} , b_{iC} : Share of stork-friendly rice and conventional rice inputs into rice sector (calculated in Table 3), $b_{iH} + b_{iC} = 1$

$$x_{jH} = x_{jR} \cdot \frac{X_H}{X_R} \qquad (4)$$

$$x_{jC} = x_{jR} \cdot \frac{X_C}{X_R} \qquad (5)$$

X_H , X_C : Production value of stork-friendly rice and conventional rice

On the other hand demand structure, which comprises two rows in the IO table, cannot be inferred from national rice demand by merely disaggregating rice from agriculture. This is because the demand for rice in one local area is quite different from that of the whole nation. For instance, at the local level, although some portion of rice demand is compensated by imports from other regions, most rice is supplied domestically and imported rice is very minor at the national level because imported rice is restricted by a trade barrior in Japan. Therefore, the demand for rice is estimated based on JA Tajima's original data for rice sales. Table 4 shows demand share for both stork-friendly and conventional. By multiplying the shares and domestic production of both types of rice, we were able to estimate intermediate demand, final demand, and exports. In the IO table, intermediate demand is classified under the food sector, while final demand is listed in final consumption expenditures. We assumed that all exports were comprised of exports to other regions within Japan and that there were no international exports. Since some conventional rice is imported from other regions in Japan, we assumed that the share of imports against total production in the rice sector was the same as that for the agricultural sector and estimated rice imports using following equation,

$$M_C = X_C \cdot \frac{M_A}{X_A} \qquad (6)$$

where, M_A is imports in the agricultural sector and M_C is imports in the conventional rice sector. The results of our estimation are shown in Table 5.

Finally, after making these modifications to the IO table, we made some modest adjustments to ensure an exact match with the totals in each row and column.

5. Scope of evaluation

The cropping area of stork-friendly farming was 41.7 hectares in 2005, and this area rapidly increased to 269.7 hectares in 2013, which translates to a conversion of 228 hectares of rice cropping over an eight-year period. In this study, we evaluated the economic impact on Toyooka of this shift of 228 hectares from conventional to stork-friendly rice cropping. Specifically, this means that 228 hectares of cropping was removed from the conventional rice sector, along with 255 million yen worth of production. Meanwhile, cropping area in the stork-friendly rice sector increased by 228 hectares, thereby bring production up by 288 million yen. In total, the Toyooka economy experienced a 32 million yen production increase. This 32 million yen can be seen as the internalized market value of stork-friendly rice farming during the period of 2008 to 2013. In this study, we evaluate the economic impacts of both the 255 million yen production decrease in the conventional rice and the 288 million yen production increase in stork-friendly rice.

In our analysis, we consider both the negative impact in the conventional rice sector and the positive impact in the stork-friendly rice sector. If the overall induced economic impact is positive as a result of the cropping conversion, we would conclude that Toyooka experienced a net positive economic impact. Theoretically, the positive direct impact (32 million yen) does not guarantee an overall net positive induced impact in total. For example, one must consider that there are two types of rice:

*Stork-friendly rice which uses non-domestic inputs;

*Conventional rice which uses domestic inputs.

The economic impact of the latter on the local economy may be larger than that from the former, even if the former is more expensive than the latter. This implies that even if the price of stork-friendly rice is higher than that of conventional rice, the economic impact on the local economy may be smaller and not always positive if the impact spills over into other regions. One important factor that engenders positive economic impact is high self-sufficiency in intermediate inputs into stork-friendly rice; however, the narrower the scope of evaluation is as compared to the national level, the lower the self-sufficiency rate becomes. As this study focuses on a very local area, the city of Toyooka, the self-sufficiency will be lower by necessity.

6. Results and considerations

6.1. Results of the analysis

The results of the analysis are illustrated in Table 6 and Figure 4. The cropping area of stork-friendly rice increased from 41.7 hectares in 2005 to 269.7 hectares in 2013, and this increase created a 56.6 million yen induced economic impact on the local economy in Toyooka. This is because, although cropping conversion yielded a negative induced effect worth 254 million yen in conventional rice, stork-friendly rice experienced a positive induced effect of 301 million yen. The resulting multiplier, that is, the ratio of direct economic impact to induced impact, was 1.75. This means that the internalized market value of stork-friendly farming multiplied the economic impact on the local economy at rate of 1.75 times. Looking at gross value added, which is calculated by subtracting intermediate inputs from gross production value, the induced value-added impact (Gross Regional Product: GRP) amounted to 46.7 million yen, which means a net positive impact on the local economy. The GRP increase per hectare of cropping area converted was 204,951 yen. The increase in GRP in sectors other than the two types of rice only amounted to 3.6 million yen with an induced GRP per hectare of area converted of 15,970 yen. 92% of all induced impact belongs to the rice sector, which implies that most of the induced GRP is enjoyed by rice farmers themselves.

The breakdown of the impact is shown in Table 7. Stork-friendly rice itself saw GRP increase by 196.5 million yen, as opposed to conventional rice which experienced a decrease in GRP of 153.4 million yen. Overall, cropping conversion yielded a 43.1 million yen increased in GRP in rice sector. Induced GRP in other sectors are very small except miscellaneous agriculture: 1.1 million yen, finance and insurance: 0.9 million yen.

These results can be summarized in the four points: 1) the internalized market value of stork-friendly rice accounts to 32 million yen during the period of 2008 to 2013, 2) when we look at the multiplier, we see that rice conversion yields a high induced effect, 3) the positive impact created by increasing stork-friendly rice exceeds the negative impact on conventional rice, and 4) most of the economic impact belongs to the rice sector, while other sectors have a very small impact on the economy.

6.2. Consideration

First, we consider why a high multiplier was obtained. Generally, there are two main factors which yield high multipliers: 1) usage of higher shares of domestic intermediate inputs for production and 2) increased added value. Considering the first factor, stork-friendly rice is actually required to use as many domestic intermediate inputs as possible. On the IO table used for the analysis, stork-friendly rice has more inputs from sectors with relatively high self-sufficiency, such as food, in which organic fertilizers are classified, and fewer inputs from sectors with low self-sufficiency, such as chemicals, in which chemical fertilizers are classified. By modifying the IO table, we were able to reflect the use of domestic products on the results of our analysis. Regarding to the second factor, generally speaking, labor-intensive sectors like agriculture are prone to have increased added value. In particular, the value-added ratio for stork-friendly rice is higher than that of conventional rice, 0.653 and 0.605 respectively (Table 8). Viewed in light of these two factors, stork-friendly rice is superior to conventional rice, and we can conclude that the high multiplier is unique to stork-friendly rice.

Next, we consider the fact that the positive economic impact on the local economy was higher than the negative impact. As mentioned before, changing rice cropping method yields both positive and negative impacts on a local economy, but the results of this analysis showed that the positive impact was larger than the negative one. Therefore, shifting rice cropping from a conventional to a stork-friendly method results in the local economy receiving a net positive economic impact. Particularly, most of this benefit is enjoyed by the rice sector itself, and one can observe from the actual situation that many farmers have suddenly shifted to stork-friendly rice. This means that conversion by some farmers induces a positive economic impact and promotes other farmers to convert their crops. This is an economic co-benefit in the truest sense, as economic growth and environmental conservation are interacting in a sustainable manner.

However, the economic impacts in the sectors other than rice are low. As Table 6 shows, induced GRP to other sectors is only 7.8% of total induced GRP, and 92.2% of induced GRP can be found in the rice sector. There are two reasons for these results. One is that, although stork-friendly rice is produced using as many domestic intermediate inputs as possible, production is still a small share of the total, and its impact on the entire local economy is minimal. The other reason is that most stork-friendly rice is exported to other regions: only a very tiny share of stork-friendly rice is consumed as intermediate inputs for other sectors in Toyooka. The smaller the share of products being used as intermediate inputs, the smaller the impact on the local economy is.

Onuma and Yamamoto (2009) also concluded that the conversion to stork-friendly rice results in an economic benefit on the microeconomic (i.e., individual farmer) level, but, our analysis is different from that of Onuma and Yamamoto (2009) in that it also contains a macro-level element. In addition, our analysis does not focus on the production cost of stork-friendly rice, but on the conversion from conventional to stork-friendly rice farming and also considers the negative economic impact on conventional rice. Nonetheless, the analysis shows that rice conversion also has an economic benefit on the macroeconomic (i.e., local economy) level, and we think these results are consistent with the conclusion of Onuma and Yamamoto (2009).

7. Policy implications and limitations

7.1. Policy implications

For policy design to promote ecosystem services, we think that the exernality of ecosystem services is too much emphasised. Foundermentally, policymakers should think at first to internalize the value of ecosystem service through higher value added of the products and then think how much value is spilled over as the externality, but currently most of policymakar as well as researchers tend to overlook the internalized value of ecosystem services. From the analysis, we found stork-friendly rice cropping has 32 million yen of the internalized value of ecosystem services. The results show that the conversion leads to promotion of the local economy and provides a reason for the local government to encourage conversion. However, the results also indicate that the economic impacts on other sectors are small. Therefore it is important to address the question how to ensure these economic impacts that spill over into other sectors, so that local policymakers can promote conservation of agro-ecosystems.

There are two solutions for this. One is to use domestic materials as much as possible for stork-friendly rice production. Using a higher amount of local materials stimulates production of the sectors which produce the inputs and induces economic impacts on the local economy. The more local inputs are used, the larger the economic impact on the economy will be. However, using more inputs of stork-friendly rice solely for the purpose of achieving a larger economic impact may be inconsistent with the objective of realizing eco-friendly faming through reduced input. Therefore, using more inputs for the sake of a larger economic impact is not recommended.

In the past, Toyooka saw its wild white storks go extinct as the result of overusing chemicals and fertilizers to achieve high-yield rice production. Keeping this tragedy in mind, it would be irrational to expect stork-friendly rice production to give priority to creating an economic impact on the economy. Of course, it is impossible to produce rice without any inputs from other sectors, so it is important to reduce inputs and environmental burden as much as possible and to produce the required inputs locally. In Toyooka, the use of local products for rice production is one of the requirements for stork-friendly rice farming. This requirement is also important for promoting the local economy.

Another solution might be to use stork-friendly rice as an intermediate input for local products. By doing this, a secondary economic impact could be generated. Although stork-friendly rice has been used as an intermediate input for Japanese sake brewing in Toyooka, local intermediate demand for stork-friendly rice remains minimal, as Table 5 indicates. A problem for local government to address is how to extend the domestic demand for stork-friendly rice. One specific solution, for instance, would be to support increased Japanese sake production and R&D for products using stork-friendly rice. Naturally, it is also important to promote final consumption of stork-friendly by local residents[1].

7.2. Limitations of the analysis

As for the limitations of the analysis, we should point out two. First, the IO analysis was implemented with data provided by the Toyooka government, JA Tajima and the Toyooka Agricultural Extension Center. Since we modified the IO table by making various assumptions, there is a chance that slight changes in the figures on the table have a significant effect on the results, and in some cases, it may even influence the conclusions we have drawn from the results. Regarding this point, we will recheck the rationality of our assumptions and seek to understand the influence of differing figures on the final results.

The second point is that there is no clear idea of the problems involved in rice cropping conversion. Actually, Nakagawa (2010) pointed out that, since farmers' decision-making is subject to labor inputs and cropping area, they face a trade-off between promoting stork-friendly rice and keeping their crop land cultivated. Farmers must consider many factors before making their decision to shift cropping, which implies that it is no easy task for farmers to expand their stork-friendly rice.

These limitations mean that the analysis does not directly connect to the expansion of stork-friendly rice; however, this study investigates the internalized value of ecosystem service and kind of economic impacts that shifts in rice cropping have generated and whether or not a net positive economic impact has been achieved. Given that these are the main features of the study, we think it provides useful insights for local policymakers in spite of these limitations.

8. Conclusions

This study evaluated the market internalized value of ecosystem services, and its impacts on the local economy (both negative and positive) generated by the shift from conventional to bio-friendly rice farming, using the case study of stork-friendly rice cropping in Toyooka, Japan. We applied an IO analysis, then considered if stork-friendly rice cropping yields a net positive economic impact on the local economy.

[1] Local people often buy rice for food directly from farmers and sometimes farmers provide rice to their relatives as a gift. As this analysis is based on statistics and data provided by the Toyooka local government and JA Tajima, these transactions are not reflected in the official statistics, and as such, cannot be addressed in this analysis.

The results are summarized as follows: 1) the internalized market value of stork-friendly rice accounts to 32 million yen, 2) conversion from conventional to stork-friendly rice yields the high multiplier of 1.75, 3) positive economic impact exceeds negative impact and there is overall a net positive economic impact on the local economy, and 4) most of the economic impact belongs to the rice sector while the impact on other sectors is very minor.

This implies that promoting conversion to stork-friendly rice is recommended, even in terms of economic development; however, most of this net benefit is reaped by individual farmers. To internalize much more value into stork-friendly rice and promote the impact on the local economy, it is important to use domestic intermediate inputs into stork-friendly rice and to utilize stork-friendly rice as intermediate input in other local products.

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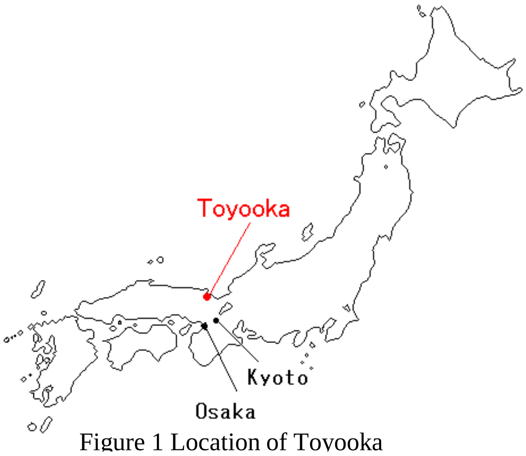

Figure 1 Location of Toyooka

Table 1 Requirements for stork-friendly farming

	Required elements	Optional elements
Environmental considerations	Reduction of agricultural chemicals Chemical-free type 1. No use of chemicals during the cultivation period Chemical-reduced type 1. 75% reduction from the normal amount used in the area (rice for food) 2. 65% reduction from the normal amount used inthe area (rice for brewing sake) An ordinary substance with Rank A for fish toxicity is used in case chemicals are used. Reduction/elimination of chemical fertilizers during the cultivation period Hot water disinfection method used Weed management in paddy ridges	Building of fish-ways or refuges for aquatic life Application of weed suppression techniques (rice bran, etc.) Field survey on aquatic life
Water management	Deepwater management Postpoment of midsummer drainage Pooling of water in rice paddies in early spring	Pooling of water in rice paddies during winter
Resource cycle	Use of compost and local organic materials	
Others	Licence acquisition for brand names (Organic JAS, Hyogo Reassurance Brand, etc.)	

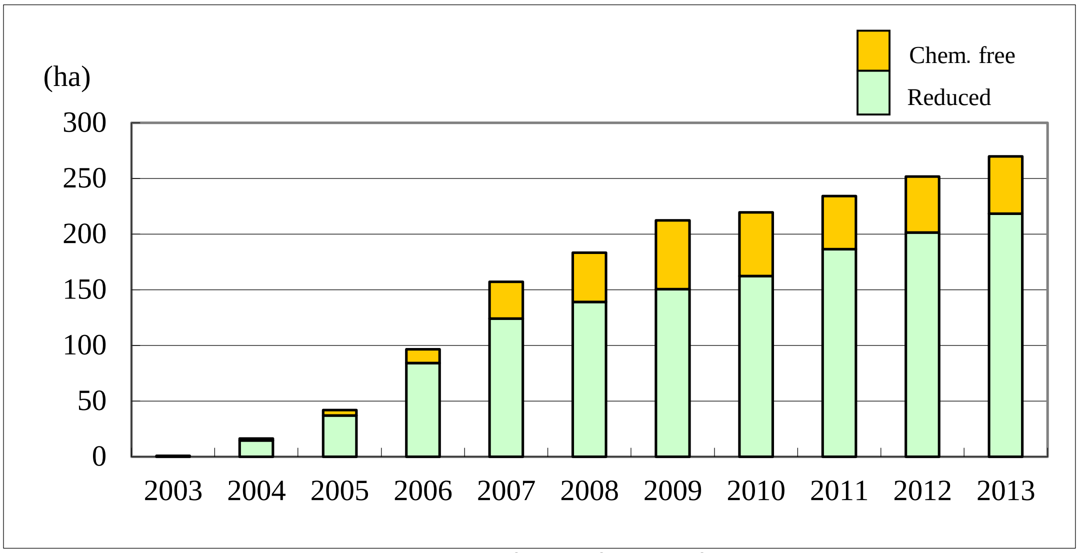

Figure 2 Share of stork-friendly farming

Table 2 Production value of each sector

	(in billions of yen)
Stork-friendly rice	0.052
Conventional rice	3.938
Miscellaneous agriculture	5.925
Total	9.915

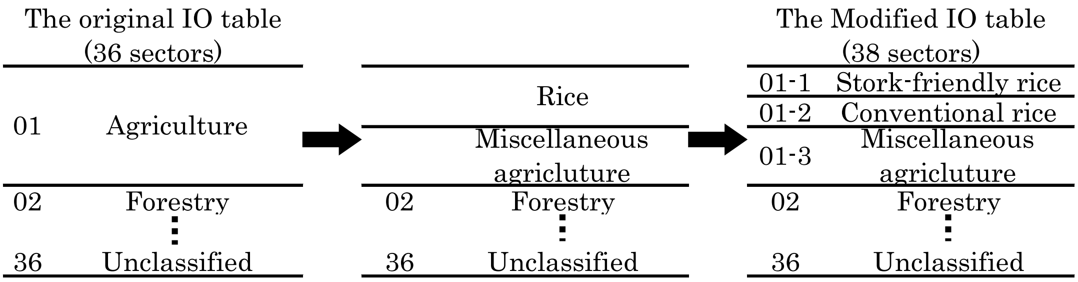

Figure 3 Process of the IO table modification

Table 3 Total input to rice production in Toyooka

(in millions of yen)

IO table Sector	Stork-friendly rice Value	Stork-friendly rice Share (*biH*)	Conventional rice Value	Conventional rice Share (*biC*)	Total Value	Total Share
Agriculture	16	1.4%	1,108	98.6%	1,124	100.0%
Food production	5	2.1%	210	97.9%	215	100.0%
Chemicals	2	0.2%	1,084	99.8%	1,086	100.0%
Miscellaneous manufacturing	2	1.5%	149	98.5%	151	100.0%
Depreciation of fixed capital	16	1.3%	1,161	98.7%	1,177	100.0%
Comp. of empl. /Operating surp.	22	2.1%	1,036	97.9%	1,059	100.0%

Source: Author estimated from the data provided by Toyooka Agriculture Extension Center.

Table 4 Share of demand for srork-friendly rice and conventional rice

	Domestic demand		Export	Total
	Intermediate	Final		
Stork-friendly rice	0.5%	8.0%	91.6%	100.0%
Conventional rice	0.4%	6.8%	92.8%	100.0%

Source: Estimated by author based on data provided by JA Tajima.

Table 5 Estimated demand for stork-friendly rice and conventional rice

(in millions of yen)

	Intermediate		Final		Export to other regions	Total demand	Import	Domestic produc.
	Food	Miscel-laneous	Private final consum. expend.	Miscel-laneous				
Stork-friendy	0	0	4	0	48	52	0	52
Conventional	17	0	791	307	3,655	4,770	-832	3,938

Table 6 Results of the analysis

	Total	Rice sector	Others
Induced production value (millions of yen)	56.6	47.2	9.4
Induced Gross Regional Product (millions of yen)	46.7	43.1	3.6
Share of each sector against total	(100.0%)	(92.2%)	(7.8%)
Induced GRP per ha of area converted (yen/ha)	204,951	188,981	15,970
Multiplier	1.75	――	――

Note: Multiplier = induced production value /net increase in rice production

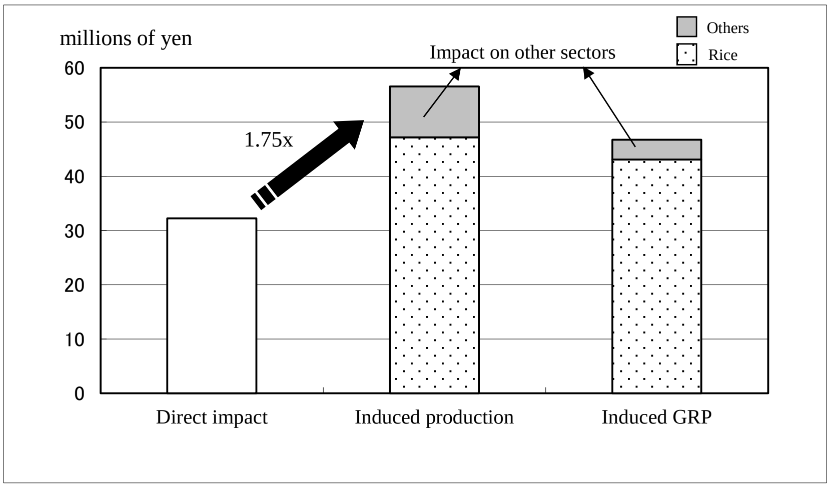

Figure 4 Impact on other sectors

Table 7 Induced GRP by sector

(in millions of yen)

	Induced GRP		Induced GRP
Stork-friendly rice	196.5	Transport devices	0.0
Conventional rice	-153.4	Miscellaneous manufacturing	0.0
Miscellaneous agriculture	1.1	Construction	0.2
Forestry	0.0	Electricity, gas and steam supply	0.2
Fisheries	0.0	Water supply and sewage treatment	0.0
Mining	0.0	Commerce	0.3
Foods	0.1	Finance and insurance	0.9
Texture	0.0	Real estate	0.0
Pulp, paper and wooden products	0.0	Transportation	0.4
Chemical products	0.0	Communication and broadcasting	0.1
Plastic products	0.0	Public administration	0.0
Bags	0.0	Education and research	0.0
Ceramic, stone, and clay products	0.0	Medical service, health and hygiene	0.0
Steer	0.0	Public service	0.0
Non-ferrous metal products	0.0	Business services	0.2
Metal products	0.0	Restaurants and hotels	0.0
Machinery	0.0	Private services	0.0
Electric machinery	0.0	Office supplies	0.0
Electric devices	0.0	Activities not elsewhere classified	0.0
		Total	46.7

Table 8 Value-added ratios

Stork-friendly rice	0.653
Conventional rice	0.605

Note: Value-added ratio is defined as the share of value added in domestic production.