

Eco-industrial Development for Bamboo Industries:

Some Discussions based on Systems Approach

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1. Introduction

Bamboo, a kind of traditional natural resource in Asia, is regarded as eco-friendly material, and has been studied with low-carbon objectives, since bamboo forest has been proven to have better carbon sequestration capability if well managed and has much higher biomass production than other timber forests. Furthermore, bamboo is an extremely diverse easy-growing plant which can be easily planted in different climatic and soil conditions.

Japan has plenty of bamboo resource, a long history of using bamboo, and now a shrinking bamboo industry in total volume. Local bamboo resources are not well used, while over half of the bamboo materials and products are imported from overseas. Figure 1 shows the decline of bamboo production of both Madake and Moso bamboo. The imported amount also decreased but the proportion of it increased against the domestic production.

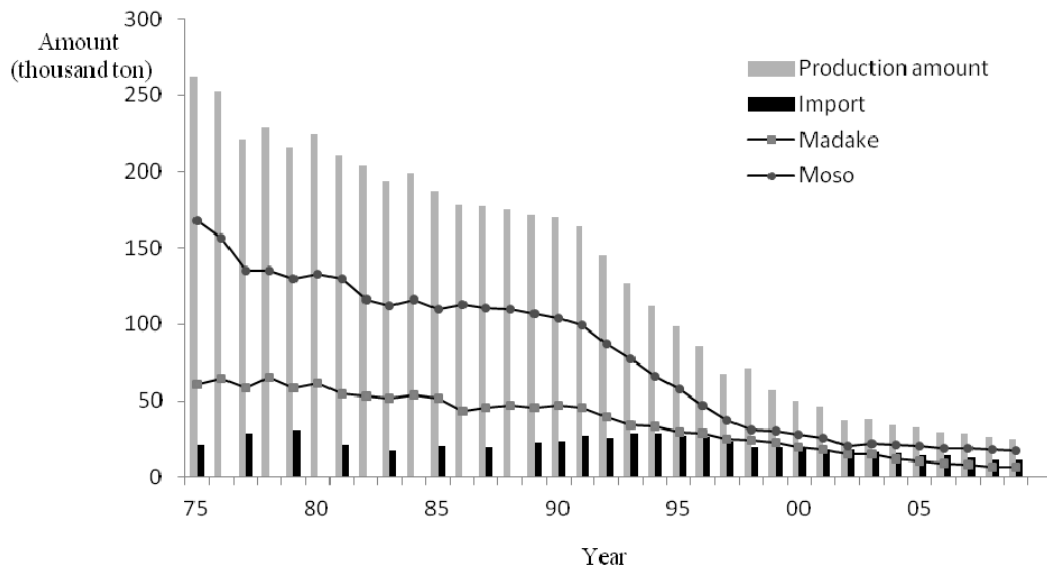


Figure 1: Bamboo Production and Imported Amount

Source: “Statistics of Non-timber forest products” – Ministry of Agriculture and Ministry and “Statistics of Japan Customs” (Ministry of Finance)

On the other side, unmanaged bamboo forests are invading vigorously into agriculture land and other forests. This dilemma is investigated through the analysis of bamboo industry in Japan in this research. It was reported the total area of bamboo forests in Kagawa Prefecture has increased to 1.8 times in recent 15 years (Figure 2). According to Private Forestry Department of Ministry of Agriculture, Forestry, and Fisheries, the problem of bamboo expansion strongly invaded into the forests, affecting the local eco-system has becoming more and more prominent; there is a need to manage the forest devastation. The bamboo expansion is also affecting Satochi-Satoyama area, causing low diversity, excessive underground stems, and low absorption of carbon dioxide. Thus, it is important to take some measures to manage the unmanaged bamboo forests.



Figure 2: the Bamboo Invasion in Kagawa Prefecture

Source: Kagawa Prefecture

2. Challenges in Bamboo Industry

As mentioned above, two questions can be raised. The first is that bamboo is eco-friendly material and also has been utilized in various ways for a long time. But why the production keeps decreasing? The second is that Japan has lots of bamboo resources, including those unmanaged bamboo forests which are invading to surrounding areas, but why the proportion of imported bamboo products keeps increasing? The two questions were investigated and discussed in this study.

Several main obstacles in bamboo industry of Japan include insecure supply due to expensive labor force and seasonal employment, weak competitive power in global and domestic bamboo market due to high labor cost, and the shortage of successors in aging society. High labor cost in Japan is considered to be the direct reason of the problems in bamboo industry. The primary processing including logging is still a low-pay and labor-intensive industry and facing the severe problem of having not enough successors, which also limits the development of mass-production in bamboo industry. So developing high added-value products at small scale, such as bamboo craft industry in Beppu City, is strongly suggested by the industrial experts for the bamboo industry in Japan. Japanese bamboo industry is facing three kinds of competition (Figure 3), which were defined from the aspect of raw material supply, bamboo products and alternative materials.

The first competition is in bamboo raw material market, in against with low price raw material from overseas, mainly from China and Vietnam. The second competition is in existing bamboo product market,

which is similar to first competition, in against with low price bamboo products from overseas. The bamboo flooring materials were compared to find that the cost of imported flooring material made in Vietnam was 1/5 of that made in Japan even including the transportation cost and tax. The third competition is in innovative bamboo products market, competing with currently existing non-bamboo products, such as bamboo fiber against cotton fiber. Based on our case study and questionnaires, it would take a long time for people to know and accept the innovative bamboo fiber and also the price needed to be adjusted to an acceptable level. From a comprehensive point of view, in order to win intense competition in bamboo market, Japanese bamboo industry should improve cost-benefit performance and integrate the resources in the whole bamboo industry systematically.

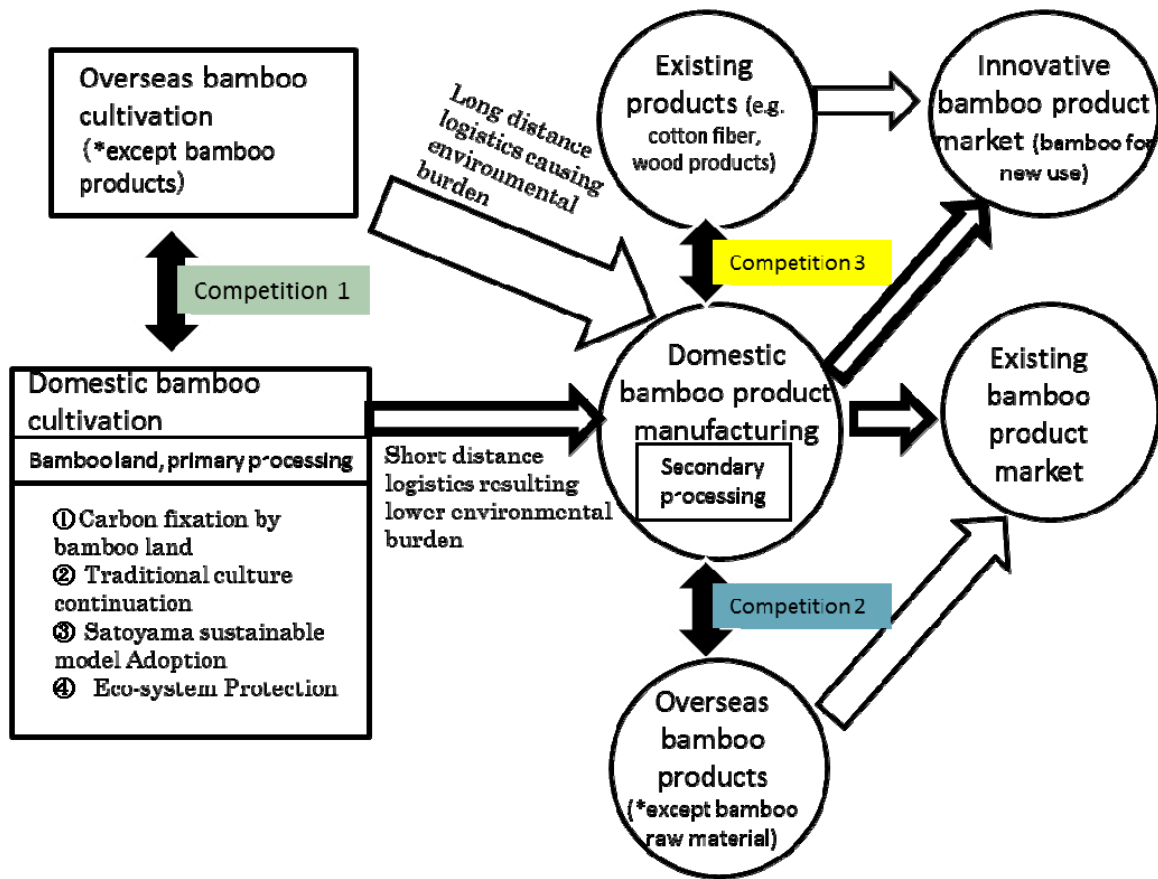


Figure 3: Three Kinds of Competition in Bamboo Industry of Japan

3. Framework for Bamboo Industry Research

Realizing mass-production using local bamboo resources is a possible solution for the questions raised in the second part. Moreover, the bamboo plantation has been proposed, where the cycling material flow was designed based on the theory of industrial ecology. Recently, new bamboo uses, such as bio-fuel production, have been developed and advanced. However, as many other eco-friendly products and industries, it is doubted that the new concepts or uses mentioned above are impossible to be industrialized due to cost-benefit considerations. The study is to analyze the opportunities of bamboo industry by applying eco-industrial

networking approaches, which contribute many successful cases of eco-industrial development. In more details, the situation of bamboo forest and industry in Japan and Asian countries was summarized based on the data collected from literature, statistics and interview information from the experts.

The industrial bamboo sectors, according to the value of the processing and grade of material used, was conventionally divided into 4 groups: premium processing (e.g. flooring, laminated furniture), medium value processing (e.g. chopsticks, mat boards), low value and bulk processing (e.g. charcoal, paper and pulp), unprocessed culms. As more and more new functions and products of bamboo are developed, there come more opportunities for bamboo industry. The new uses such as bio-fuel production were also contained by considering the road map of the new technologies (Figure 4). The framework of bamboo industry was built up based on systems approach, into 3 stages including bamboo resources management, primary processing and secondary processing, with sub-sectors for each stage. The possibilities of improving production efficiency and cost-benefit performance will be discussed in the optimization problem after establishing the models.

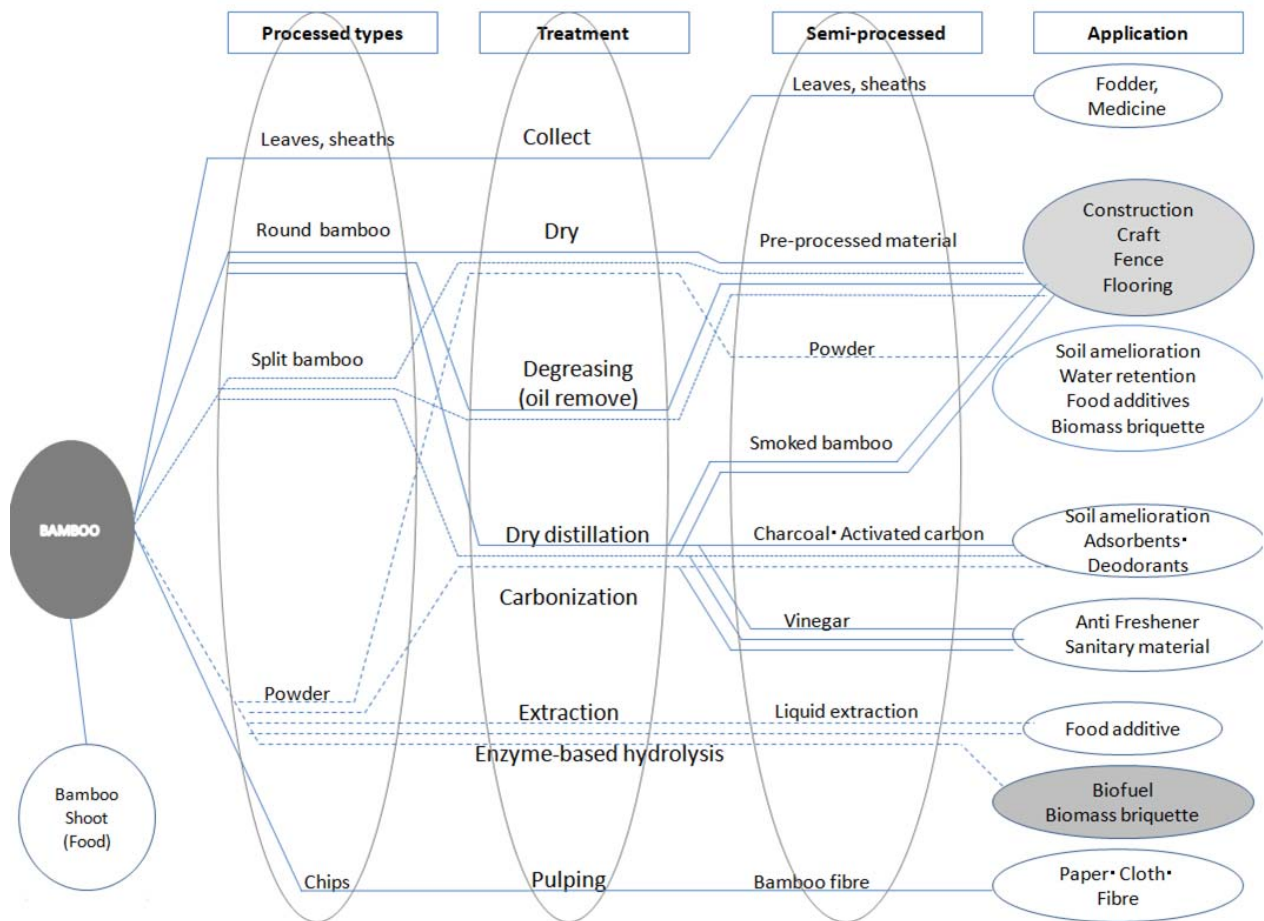


Figure 4: Bamboo Utilization

The framework includes the following 4 sub-systems (Figure 5):

1. Bamboo land resources (for sustainable bamboo forest management)

In this sub-system, solving bamboo forest invasion problem is focused. Unmanaged bamboo land can be

converted into other timber forest by cutting off all the bamboo. But this method may not produce bamboo raw materials at high quality. Another method is to convert unmanaged bamboo land to managed bamboo land, which may provide various bamboo raw materials. Both methods have been compared in the study. And the decision should be made based on the demand of bamboo raw materials and the land use strategy.

2. Primary processing system (to improve production efficiency)

According to the production application, three levels of primary processing have been classified. The quality and quantity of raw material, labor input, technology input, production input and output data will be collected for production model estimation. The waste from high-level production is used into low level production, which is suggested in eco-industrial development. The contents of this sub-system included measuring productivity of each production level in optimized complex secondary production system; calculating the amount of raw bamboo in demand, and considering the possibility of adopting machinery equipment. The calculated amount of bamboo in demand is provided for bamboo land resources sub-system.

3. Secondary processing system (to improve utilization efficiency):

This sub-system analyzes the raw materials quality, quantity, labor input, technology input, equipment input, production input and output of existing and innovative products, to calculate the production model and design the manufacturing combination of existing and innovative products, base on their production correlation. Following the principles of eco-industrial development, the residual will be reused for the lower level process. The aim is to improve utilization efficiency and the cost-benefit performance of final productions.

4. Bamboo raw material storage and logistic system (to reduce the cost of distribution and supply):

Bamboo is harvested every autumn. In order to ensure the stable annual supply, it is important to consider the storage after harvested. Besides, transporting hollow bamboo materials is low efficient. If crashed bamboo is needed, the crashing facility is better to be located close to the storage or bamboo forest. Such kind consideration, together with the relationship of facility locations for each step, should be included in the designing of optimal storage and logistic system.

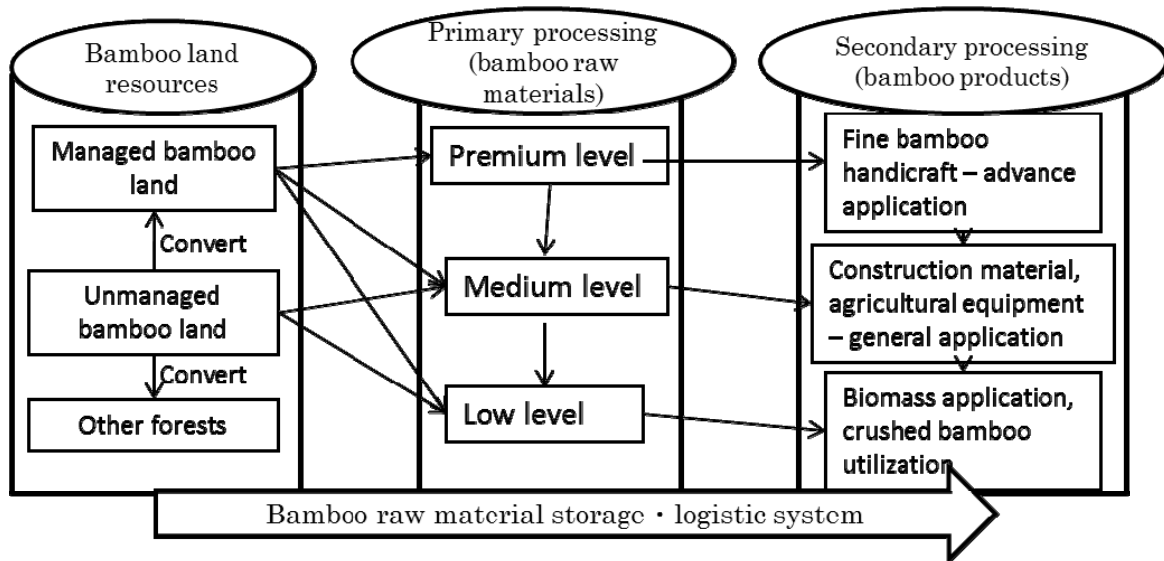


Figure 5: Framework for Bamboo Industry

4. Conclusions

Some suggestions for the development of Japan bamboo industry are concluded. Bamboo sector in Japan should enhance the strength of its current production, such as extraordinarily high quality, unique design, and special functions for high value-added products to reduce the competition intensity. Secondly, domestic bamboo sector should grasp new opportunities such as biomass use, which also helps to utilize the residuals from other sub-sectors. Thirdly, the bamboo industry needs to be adjusted as a comprehensive system from bamboo forest cultivation, logging, to processing, storage and logistics and so on, to obtain the optimal performance by taking the advantage of agglomeration effects. Fourthly, the environmental benefits of bamboo forest, such as carbon sequence, need to be taken into account for applying governmental subsidy. Finally, bamboo forest, as tourism resource, can be combined with local tourism industry. By managing the bamboo forests and utilizing bamboo products, we may be able to revitalize the deteriorating Satochi-Satoyama production system and the local community.

The development of bamboo industry proposed in this study is made from the academic viewpoint, even based on many empirical case studies. The realization of the proposal needs the cooperation of various stakeholders in the production chain. So ensuring the economic profit is one of the objectives in this study, which is also the basement for practical cooperation. Moreover, it supports the management of bamboo forest; and proper management of bamboo forests for quality and quantity are essential to the bamboo industry and local environmental problems in the future. The systematic consideration of time and space is expected to solve the questions mentioned at the beginning and make the bamboo forest and industry one possible solution for low-carbon society.

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