Journal of Developments in Sustainable Agriculture 5: 101-109 (2010)

Enhancing the Scope of Agricultural Education for Sustainable Development by Taking Advantage of the Comprehensive Programs at Sakado High School: An Example from Indonesia

Katsuyoshi Ishii[1] and Morio Kato[2]*

[1] University of Tsukuba Senior High School at Sakado, Sakado, Saitama 350-0214, Japan
[2] Graduate School of Life and Environmental Sciences, University of Tsukuba, Tsukuba, Ibaraki 305-8572, Japan

The University of Tsukuba's Agricultural and Forestry Research Center (AFRC) is hosting the UNESCO-APEID International Symposium on Agricultural Education for Sustainable Development (Ag-ESD) from 2008 to 2013 to contribute an agricultural viewpoint to the United Nations "Decade of Education for Sustainable Development." The goals of this activity are to promote the development of an energy and environmental education model suitable for use in developing countries by taking advantage of the knowledge and experience gained through the comprehensive programs of the University of Tsukuba's Senior High School at Sakado (UTSS).

In 2008, we selected Bogor Agricultural University's Kornita Senior High School in Indonesia to cooperate with UTSS on developing an energy and environmental education model. We focused on bamboo, a common native material with deep roots in the country's culture, and developed courses based on the concrete results produced by the comprehensive programs at UTSS. During our first visit, we implemented the educational cooperation model, and developed a shared understanding of bamboo as a material for energy and environmental education. During our second visit, we presented a draft education curriculum and lecture contents, then provided a model lecture that introduced the multiple functions of bamboo, and demonstrated charcoal production and use. We created English teaching materials that combined an instructional objective with a lesson plan that combined theory from multiple scientific disciplines with hands-on experience applying this knowledge. By reviewing a native material using the approach used in the comprehensive programs at UTSS, this activity promises to develop an excellent, unique, energy and environmental education model to promote sustainable development based on the utilization of an alternative biomass material while simultaneously promoting environmental preservation.

Key words: education for sustainable development, energy and environmental education, comprehensive educational programs, bamboo, Indonesia

Introduction

1. Agricultural Education for Sustainable Development

The University of Tsukuba's Agricultural and Forestry Research Center (AFRC) has held the Tsukuba Asian Seminar on Agricultural Education annually since 1979 as an Associated Center in the Asia-Pacific Program of Educational Innovation for Development (APEID) in the field of vocational and technical education. Tsukuba Asian Seminar on Agricultural Education's and AFRC's activities have been closely related to the promotion of sustainability through agricultural education. Since 2008, AFRC has hosted the UNESCO-APEID International Symposium on Agricultural Education for Sustainable Development (Ag-ESD), which is planned to continue until 2013, with the goal of

Received: October 23, 2009, Accepted: December 2, 2009
* Corresponding author: Graduate School of Life and Environmental Sciences, University of Tsukuba, Tennodai 1-1-1, Tsukuba, Ibaraki, 305-8572, Japan.
Tel/Fax: +81-29-853-6673, E-mail : katomo@sakura.cc.tsukuba.ac.jp

contributing an agricultural viewpoint to the United Nations "Decade of Education for Sustainable Development." This program aims to contribute to education for sustainable development (ESD) by emphasizing the agricultural sciences, and especially their potential contribution to ESD (i.e., Ag-ESD). Various approaches are required to gradually spread the use of excellent programs in ESD to enhance agricultural practices and improve the depth of knowledge by taking advantage a multidisciplinary approach that combines theory with practice (Elias, 2009).

2. International Cooperation Initiative

Japan's Ministry of Education, Culture, Sports, Science and Technology created an International Cooperation Initiative, "Formation of ESD International Cooperation Models Utilizing the Knowledge of Universities," to promote international cooperation in which the knowledge gained by universities contributes intellectually to the sustainable development of a developing country. Main activities include the promotion of a basis for educational cooperation, the formation of local enterprises, provision of information on a local resource, and encouragement of practical use and promotion of a locally available resource. These activities respond to demands to strengthen practical applications of ESD and to develop and expand its theoretical basis. In collaboration with universities, the Ministry of Education, Culture, Sports, Science and Technology has been developing model activities and practical teaching materials that can be used in developing countries by the diverse people who are engaged in ESD activities.

3. UTSS and its Comprehensive Program

UTSS has established the first comprehensive programs in integrated science in Japan. The courses are presented within an education system that provides a combination of general education and specialized education to raise brilliant students who possess a broad-based academic ability and the ability to work within society to promote social development.

UTSS has a good track record of international exchanges through extracurricular study through its contributions to the planning of Tsukuba Asian Seminar on Agricultural Education. For example, AFRC and UTSS have jointly created and managed the Ag-ESD organizing committee. UTSS also has a good record of providing energy education (Ishii, 2004).

4. Involvement of AFRC and UTSS in the International Cooperation Initiative

In fiscal year (FY) 2008, AFRC and UTSS applied for funding under the International Cooperation Initiative, and their program "Enhancing the Practice and Depth of Ag-ESD through Knowledge of Comprehensive Programs" was accepted under the "Development of Education Modules and Activity Models" category. AFRC's human network in the Asia-Pacific area and the abundant environmental education knowledge of UTSS were combined to deepen and expand ESD by improving education in this field in developing countries (Fig. 1). Under this activity, outstanding teaching materials are developed for energy and environmental education that are suitable for use in developing countries by taking advantage of the expertise gained through the comprehensive programs of the UTSS. The purpose of this activity is to promote joint development of an energy and environmental education model based on the utilization of native materials in the target country. An important feature of this activity is that it adds an energy perspective to agricultural and environmental education that benefits from an understanding of the present high school education conditions in developing countries. In Indonesia, for example, AFRC and UTSS developed teaching materials that focused on the use of bamboo and bamboo charcoal to provide a practical education for high school students.

Plan and Activities

1. Partner School in Indonesia

In FY2008, we selected Kornita Senior High School (KHS) as our partner in the development of an energy and environmental education model. KHS is a private high school on the campus of Indonesia's Bogor Agricultural University. The school is eager to implement a program of environmental education. Various educational activities, such as research on local landscapes, drainage basins (watersheds), and gardening on the school's grounds, are conducted. This school is also eager to provide

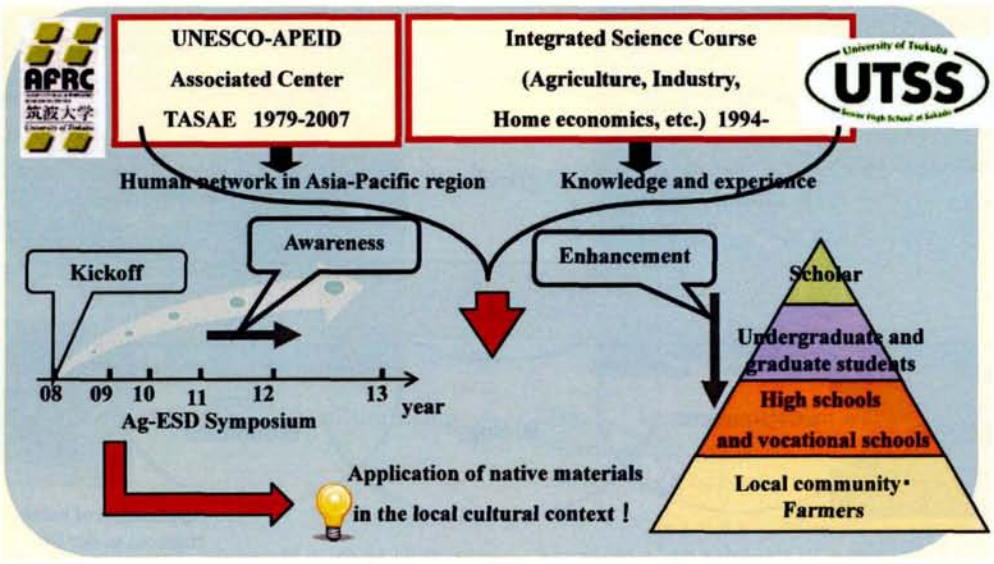

Fig. 1. Overview of the project "Enhancing the Scope of Agricultural Education for Sustainable Development by Taking Advantage of the Comprehensive Programs at Sakado High School."

education in the field of information technology. Students are taught about Japanese language.

2. Choice of a Suitable Material for an Energy and Environmental Education Model

We chose bamboo because of its important role in Indonesia's culture and because it is a common and abundant native material. With bamboo as our focus, we developed lessons based on the ability to achieve specific results, which is a feature of the integrated science courses at UTSS. The subjects that we developed include the production of bamboo charcoal (in cooperation with the Department of Agriculture), the operation of a Stirling engine powered by bamboo charcoal (in cooperation with the Department of Industry), taking advantage of purification of water using bamboo charcoal, other aspects of bamboo use in the daily lives of local people (in cooperation with the Department of Home Economics), and geographical considerations (such as the national distribution of bamboo, in cooperation with the Department of Geography) (Fig. 2).

Bamboo is a common plant in many rural areas of Indonesia (Arinasa, 2005; Arinasa and Widjaja, 2005; Kashiwagi, 1998; Numata, 1978; Widjaja, 2005). Bamboo is used as important resource or tool in the life of local people, who use it for construction, handicrafts, agricultural tools, and as musical instruments (Fig. 3, 4). It is also traditionally used as fuel by converting it into charcoal (Astuti and Arinasa, 2002). As a result, bamboo is easily available and a highly suitable subject for Ag-ESD.

3. Visitation Plan and Results of This Activity

3.1 Activities during the first visit

Three staff from AFRC and four teachers from UTSS visited Bogor Agricultural University and KHS from 18 to 21 January 2009 and outlined and discussed the objectives, processes, and outcomes of the proposed program. We developed a plan for implementing the proposed educational cooperation model and confirmed our shared understanding of the potential utilization of bamboo as a material for energy and environmental education. We agreed with our Indonesian colleagues that teaching materials made from bamboo and bamboo charcoal would be useful. KHS requested that the teaching material should be inexpensive, easy to understand, and attractive, and that the curriculum should integrate subjects such as chemistry, biology, and economics. UTSS offered annual syllabus planning, developed the lesson contents, created the instructional plan and an educational guidance proposal, and supported implementation of the lessons. UTSS also proposed using a questionnaire before and after the course to confirm what students learn-

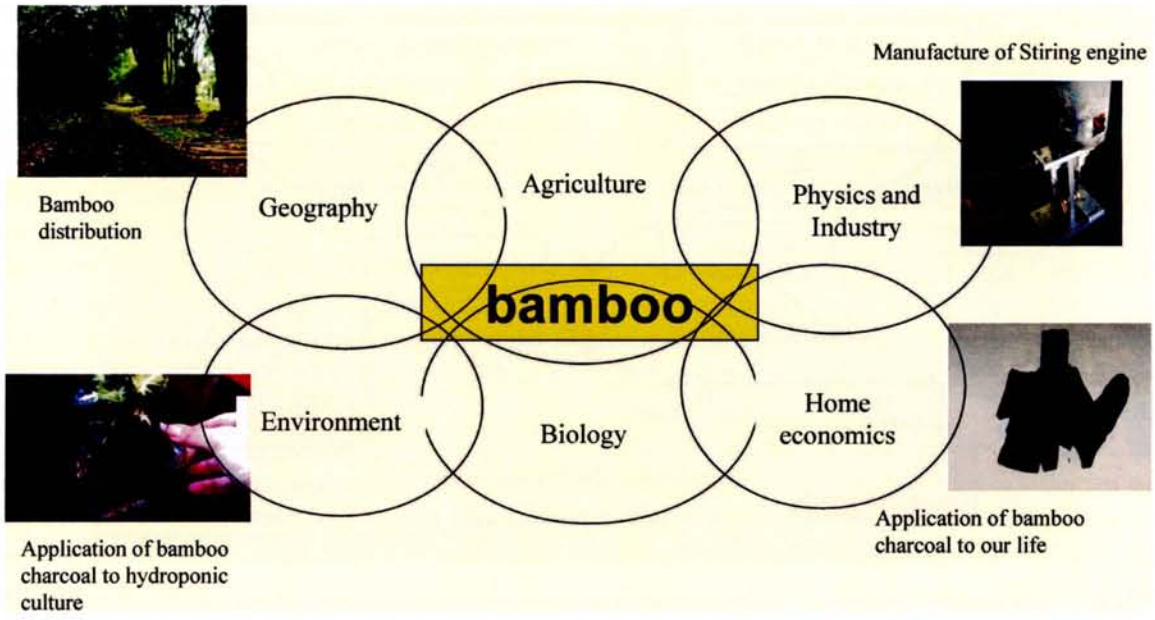

Fig. 2. Development of teaching materials for the energy and environmental education program that focuses on bamboo in Indonesia.

Fig. 3. An illustration of the diversity of the bamboo species that grow in Indonesia.

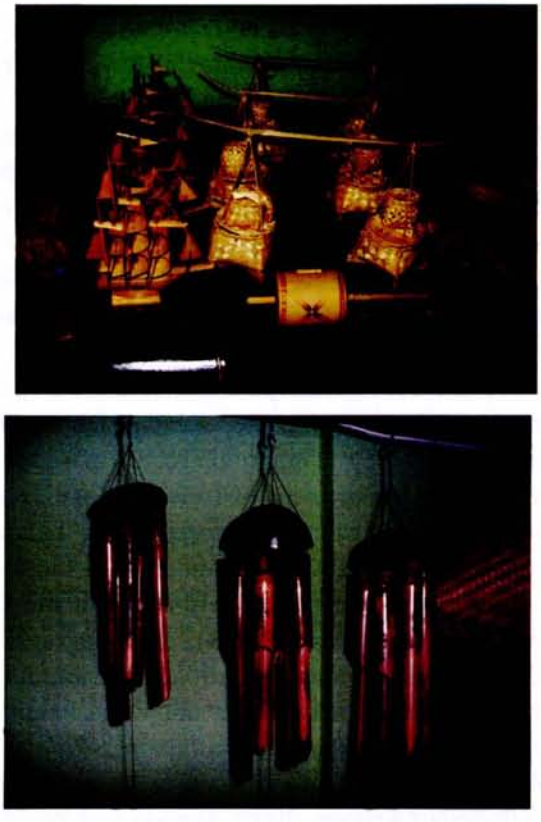

Fig. 4. Various kinds of handcrafts and musical instruments made from bamboo in Indonesia.

Fig. 5. Demonstration of hydroponic culture using bamboo charcoal.

Fig. 7. Demonstration of the production of bamboo charcoal for teachers and students of the Kornita Senior High School.

ed. In planning the syllabus, planners agreed that it should include aspects of geography, physics, industry, biology, agriculture, home economics, and the environment. Lectures, experiments, and training would be designed to provide an effective balance between theory and hands-on experience so that students would both understand the course materials and be able to adopt them in practice. Teaching materials would be prepared in English.

During this visit, UTSS teachers provided model lectures on potted hydroponic culture using bamboo charcoal (in cooperation with the Department of Agriculture; Fig. 5) and on the application of bamboo charcoal to the daily lives of local people (in cooperation with the Department of Home Economics). A Stirling engine powered by bamboo charcoal was also demonstrated to KHS teachers and students.

3.2 Activities during the second visit

Three staff from AFRC and two teachers from UTSS visited KHS from 22 to 26 February 2009, demonstrated the study plan, and provided a sample lesson. We presented a draft proposal for the energy and environmental education curriculum (Table 1) and the contents of the instructional materials. The teaching plan proposed the use of 32 study periods per year in which the focus was on uses of bamboo and bamboo charcoal, with the goal of teaching students about energy and environmental problems and opportunities related to these materials. The approach is to use subjects such as biology and physics to support the study of more holistic topics rather than studying the theory of (for example) biology in isolation from its practical uses. An example of the details of a teaching plan is shown in Table 2. Examples of the text used for the energy and environmental education were presented as a "discussion starter" for this activity (Fig. 6). The requirements for the education curriculum and for improving the teaching plan and instructional materials were discussed with the teachers at KHS.

After discussing the curriculum, the UTSS teachers presented a sample lesson about the geographical characteristics of bamboo. The multiple functions of bamboo charcoal in agriculture were discussed, and research on the purification of irrigation water using bamboo charcoal and its influence on paddy rice yields and the environment were presented by AFRC staff (Yonekawa *et al.,* 2004). A simple method for the production of bamboo charcoal that is suitable for KHS staff and students and tools for its production were explained and demonstrated by AFRC staff (Fig. 7).

3.3 Outcomes and problems

The primary product of this activity was the development of teaching materials, consisting mainly of an instructional objective and an instructional plan. The proposed curriculum and teaching materials will be tested at KHS, and their effectiveness will be confirmed using questionnaires distributed to both students and teachers in the next year.

To implement this curriculum as a new subject of study at KHS, finances and staff assignments must still be established. Certification for students who complete the course of study has also been requested so that students can relate the learning directly to their careers.

Table 1. Program of study for the year

Section hours		Subject	Themes	Planners
1	2	Introduction	Introduction	Nakamura/Oka
1	2	Biology	Species biodiversity of bamboo	Nakamura/Oka
1	2	Biology	Biology of bamboo1	Nakamura/Oka
1	2	Biology	Biology of bamboo2	Nakamura/Oka
2	2	Geography	Natural environment of Indonesia 1	Konno
2	2	Geography	Natural environment of Indonesia 2	Konno
2	2	Geography	Energy and environmental problems in Indonesia	Konno
2	2	Geography	Sustainable development in Indonesia: focusing on the potential of bamboo	Konno
3	2	Physics and Industry	Building and operating a Stirling engine 1	Honkyu/Fukazawa
3	2	Physics and Industry	Building and operating a Stirling engine 2	Honkyu/Fukazawa
3	2	Physics and Industry	Learning about the efficient utilization of energy 1	Honkyu/Fukazawa
3	2	Physics and Industry	Learning about the efficient utilization of energy 2	Honkyu/Fukazawa
4	2	Agriculture	Making bamboo charcoal and improving its quality 1	Adachi/Kato
4	2	Agriculture	Making bamboo charcoal and improving its quality 2	Adachi/Kato
4	2	Agriculture	Relationships between humans and local agriculture 1	Adachi/Kato
4	2	Agriculture	Relationships between humans and local agriculture 2	Adachi/Kato
4	2	Agriculture	Absorption of substances in the soils of rice fields using bamboo charcoal 1	Adachi/Kato
4	2	Agriculture	Absorption of substances in the soils of rice fields using bamboo charcoal 2	Adachi/Kato
5	2	Home Economics	Necessity of utilizing bamboo	Kobayashi
5	2	Home Economics	Learning about bamboo charcoal and how to use it in our daily lives	Kobayashi
5	2	Home Economics	Enjoying life more by taking advantage of bamboo charcoal 1	Kobayashi
5	2	Home Economics	Enjoying life more by taking advantage of bamboo charcoal 2	Kobayashi
6	2	Environment	Relationships between energy and environmental problems 1	Ishii/Tatemoto
6	2	Environment	Relationships between energy and environmental problems 2	Ishii/Tatemoto
6	2	Environment	Growing plants in bamboo charcoal 1	Ishii/Tatemoto
6	2	Environment	Growing plants in bamboo charcoal 2	Ishii/Tatemoto
6	2	Environment	Role of bamboo forests: water control functions in river basins 1	Ishii/Tatemoto
6	2	Environment	Role of bamboo forests: water control functions in river basins 2	Ishii/Tatemoto
7	2	Consolidation	Finding ways to improve our daily lives using bamboo or bamboo charcoal 1	Shiraishi/Kudo
7	2	Consolidation	Finding ways to improve our daily lives using bamboo or bamboo charcoal 2	Shiraishi/Kudo
7	2	Consolidation	Student presentations of ways to improve our daily lives using bamboo or bamboo charcoal 1	Shiraishi/Kudo
7	2	Consolidation	Student presentations of ways to improve our daily lives using bamboo or bamboo charcoal 2	Shiraishi/Kudo

Table 2. An example of the details in a basic teaching plan

Section 1: Introduction / Biology
Number of hours: 8

Objectives of this section • Introduce students to this course • Help the students to understand the biological characteristics of bamboo
Periods 1-2 (4 hrs): Introduction / Species biodiversity of bamboos
1. Introduction (1) Help students to understand why we study bamboo (and especially bamboo charcoal) (2) Help students to think about three key words: sustainability, diversity, and environment 2. What is bamboo or *take*? (1) Images of bamboo and *take* (2) Phylogeny and classification (3) Characteristics of bamboos in Indonesia and of *take* in Japan 3. Ecology of bamboos and *take* (1) Distribution (2) The role of bamboos in ecological succession
Period 3-4 (4 hrs): Biology of bamboos and *take*
1. Organs and tissues (1) Structure (2) Formation of stalks, leaves, and roots (3) Formation of flowers 2. Life cycle (1) Reproduction (2) Growth (3) Flowering and death
Notes Visual aids: Preparation of teaching materials (PowerPoint files etc.) with various images and photos Manuals: Compiling observation methods

Conclusions

By selecting a native material from the host country (bamboo) and evaluating it from the perspective of the type of comprehensive program delivered at UTSS, it was possible to develop a unique and excellent model for energy and environmental education that emphasizes the importance of sustainable development. The program is conscious of the need to promote the utilization of bamboo as an alternative source of energy and biomass that can also contribute to environmental preservation. By emphasizing an approach to learning that combines theory with hands-on practice, the approach facilitates learning and the transfer of practical knowledge to students. A similar approach can be used in the future to help students understand other environmental problems. The approach also promotes scientific thinking that can assist a student's future research activities.

Making a potted hydroponic culture plant with bamboo charcoal

0. What is hydroculture?

Hydroculture is a method of growing plants without soil. In hydroponics, plants grow in absorbent aggregates and nutrients. Hydroculture is also referred to as passive hydroponics.

1. Advantages of the use of bamboo charcoal in hydroculture

- Air purification effect: the bamboo charcoal absorbs harmful substances, deodorizes the air, controls the humidity and has antibacterial effect.
- Healing effect: the scent of phytoncide, a volatile substance that comes out of bamboo charcoal, causes people's concentration to improve.
- Suitable for indoor planting: it is clean without soil, easy to take care of, and attracts less vermin.
- Thinned bamboo can be used effectively, without being disposed. (bamboo forests should be thinned occasionally as bamboos grow and increase fast)
- The nutriment in bamboo is utilized effectively, and prevents decay of roots.

2. Making a potted hydroculture plant with bamboo charcoal

- Materials to be used
  - Bamboo charcoal (regular charcoal is also usable)
  - Zeolite (for preventing root decay)
  - Transparent container (bottles, glasses, etc.)
  - Foliage plant
  - Rubber hammer
  - Sieve
- Making procedure
  1) Break the bamboo charcoal into small pieces with a hammer (Figure 1).
  2) Strain the broken pieces and get rid of the powdered charcoal
  3) Put zeolite on the bottom of the container to make it 1 cm thick (Figure 2). Zeolite is not necessary if it is unavailable because bamboo charcoal itself prevents roots from decaying.
  4) Put relatively large pieces of crashed bamboo charcoal on the zeolite to the depth of one third of it (Figure 3).
  5) Put the plant in the center of the container, and put the bamboo charcoal around it (Figure 4). The small pieces of bamboo charcoal should be placed in the middle of the container, and the large pieces should be used on the surface of it.
  6) Put water into the container slowly to make it one-third deep (Figure 5).

Fig. 6. An example of the text used as a "discussion starter" by teachers at UTSS.

Acknowledgements

This project was supported by the program for 'The Development of Education Modules and Activity Models, Developing University-based ESD International Cooperation models' under the International Cooperation Initiative of Japan's Ministry of Education, Culture, Sports, Science and Technology. We thank Prof. Naoki Sakai of AFRC, the project representative, and Prof. Toru Nakamura, principal of UTSS, for organizing this project. We especially thank Dr. Hideo Hasegawa, Niigata University, for planning and promoting this project, Mr. Yoshikazu Tatemoto (JICA-Junior expert and teacher at UTSS) for coordinating this project in Indonesia, and Mr. Subagio Siswodiwiryo, principal of KHS, for agreeing to participate in this project. We also thank all members of this project at AFRC, UTSS, and KHS for their devotion and their contributions to the success of the project.

References

Arinasa I.B.K., 2005. Population study of Jajang aya (*Gigantochloa* sp.) in Panglipuran village Bali, Indonesia. Bamboo J. 22, 22–28.

Arinasa I.B.K. and Widjaja E.A., 2005. Bamboo diversity in Bali, Indonesia. Bamboo J. 22, 8–16.

Astuti I.P. and Arinasa, I.B.K., 2002. Traditional bamboo charcoal in Bali, Indonesia. Bamboo J. 19, 53–59.

Elias. D., 2009. Food security and agriculture: Applying ESD to global challenges for a sustainable future. J. Devel. Sust. Agric. 4, 1–6.

Ishii, K., 2004. Development after the education practice for energy education. Bull. Res. Univ. Tsukuba Sakado Senior High School 44, 45–49 (in Japanese).

Kashiwagi, H., 1998. Life and bamboos in Indonesia. Rep. Fuji Bamboo Garden 42, 116–123 (in Japanese).

Numata, M., 1978. Bamboos of Indonesia. Rep. Fuji Bamboo Garden 22, 2–6 (in Japanese).

Widjaja, E.A., 2005. Bamboo diversity of Alor and Pantar Islands, Indonesia. Bamboo J. 22, 17–21.

Yonekawa K., Sugawara, K., Sakai, N. and Hayashi, H., 2004. Improving the environmental effect on paddy cultivation with irrigation systems of eutrophicated water purified by an application of bamboo charcoal. Bull. Agric. For. Res. Center Univ. Tsukuba 17, 29–42 (in Japanese with English abstract).