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# Research, Education and Extension of Environmental Technologies in Developing Countries

## - Case Study of Tokyo University of Agriculture and Technology

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**Abstract:** Universities have a unique ability to support international cooperation involving environmentally and socioeconomically sound development, through integrated interactive field and laboratory research, and the associated dissemination of new information and technologies to targeted populations. Since 2008, the Tokyo University of Agriculture and Technology has undertaken three rural development initiatives, in Vietnam, Uzbekistan and Brazil. This paper discusses the University's attempts to organize on-site development education, studies focused on the challenges of family farms, and the diffusion of appropriate technologies for improved production. Students and staff of the University and its local sister schools cooperated on the projects, with development intervention financing from the Japan International Cooperation Agency (JICA), and scientific research funding from additional sources. Participation of the rural beneficiaries in all phases of the initiatives boosted the projects' effectiveness. Today's increasing donor expectations of universities' social contributions may further mobilize academic human resources and lead to better global society.

**Key Words:** Agroforestry, Charcoal, Grassroots technical cooperation, Research grant, Silk.

### 1. Introduction

In the United States, the fundamental mission of Land Grant Universities has been government-university-private sector partnerships for the advancement of practical research associated with national needs, based on the notion of public service and the transfer of research results to better society [A)]. Originally, land-grant education was intended for the children of ordinary people in agriculture and mechanical engineering, with an emphasis on pragmatic studies as stipulated by the Morrill Acts of 1862 and 1890. The Hatch Act of 1887 specified that the research functions of the universities be carried out by agricultural experiment stations. The resulting information and technology were to be disseminated through the Cooperative Extension Service, as designated by the Smith-Lever Act of 1914. In an age when half of the US population lived on farms, agriculture was the main business of the day and thus a prime focus of the land-grants [A)].

However, World War II, the 1970s crisis of economic competition with Germany and Japan, and a shift in industrial structure from rural to military and civilian industries changed the orientation of the original land-grant model from public service to one based on non-agricultural commercial sectors. This new emphasis was also adopted by private universities all over the country [A)]. Various national acts passed in the 1980s linked American universities to industry in order to spur the nation's economic recovery. This seemingly provided a lesson for the incorporation of national universities in Japan in 2004 during its long economic slump.

Article 22 of Act No. 112 of 2003 (the National University Corporation Act) entitled a National University Corporation to conduct the following services in Japan [B)]:

(i) To establish a National University and operate it.
(ii) To provide students with counseling on their education, career paths, and physical and mental well-being, as well as other forms of support.
(iii) To conduct educational and research activities with parties outside a National University Corporation, by receiving commissions or in joint collaboration.
(iv) To furnish educational opportunities to the public by university extension courses and other programs.
(v) To disseminate research outcomes of a National University and promote the use of them.
(vi) To finance projects designated by government ordinance, which promote the practical application of inventions at a National University.
(vii) To conduct services ancillary to the matters listed in the items above.

While item (i) relates to academic research and education functions, and (ii) refers to student services, items (iii), (iv), (v) and (vi) define a university's outreach or social contribution, as

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functions of the land-grant Cooperative Extension System.

The Act became effective in April 1, 2004, accompanied by the Intermediary Objectives (1st period; April 2004 to March 2010) prescribed by the Minister of Education, Culture, Sports, Science and Technology based on Article 30 of the Act, and corresponding Intermediary Plans under Article 31 and prepared by each National University Corporation. The first Administrative Council of the National University Corporation of Tokyo University of Agriculture and Technology was held that month with sixteen councilors including nine external members [C] to constitute "equal to or more than half" of the Council as required by item (iii), paragraph (2), Article 20 of the Act, which demanded an objective performance review from a university corporation. In view of the University's Intermediary Plan, that stipulated the promotion of comprehensive and interdisciplinary research in partnership with society to fulfill its social responsibilities, and global contributions through academic exchange and cooperation [D], Councilor Mr. Atsushi Hatakenaka, then Vice President of the Japan International Cooperation Agency (JICA) and a former Japanese ambassador to Australia and South Africa, stressed a technological university's potential in facilitating sustainable development of underdeveloped countries, which are still heavily dependent upon the primary sector, and food processing and light manufacturing of the secondary sector.

The predecessors of Tokyo University of Agriculture and Technology, the Meiji Interior Ministry's Agricultural Training Institute and Sericulture Experiment Section, were founded in 1874 [E] to back up the two most important national industries at that time. These industries contributed to rapid industrialization and modernization of Japan before World War II. (Even today, the Emperor plants rice and the Empress feeds silkworm in the Palace of Central Tokyo, in the annual imperial rites for prosperity of the nation). In 1890, the Agricultural Training Institute was expanded and integrated with the Secondary Department (renamed Practical Applications Department in 1898) of the Agricultural College of the Imperial University (today's University of Tokyo), which later incorporated itself into Tokyo Imperial College of Agriculture and Forestry in 1935. On the other hand, the Sericulture Experiment Section became Tokyo Imperial College of Sericulture in 1914. After World War II, both Imperial Colleges of Agriculture and Sericulture merged into Tokyo University of Agriculture and Technology in 1949, with its Faculty of Agriculture and Faculty of Textile. Around that time, cotton textiles took over the lead in Japanese exports of silk threads and fabric. Finally in 1962, the Faculty of Textile changed its name to Faculty of Engineering when Japanese exports of all textile goods were surpassed by iron, steel, and machinery. During this reform, the Departments of Sericulture and Practical Sericulture were transferred from Faculty of Textile (later Engineering) to Faculty of Agriculture.

In this way, Tokyo University of Agriculture and Technology has been an academic and technological engine for the modern industrial development of Japan, both in primary and secondary (especially light industry) sectors, with an emphasis on practical applications for farm fields and factory floors. Therefore the University may find its special mission in international cooperation or globalized outreach to developing countries, which may in return enrich research and education as intended in the land-grant model. In carrying out this mission faculty and students experience first-hand the realities of underdevelopment, gain insights into sustainable rural development, and are motivated to conduct participatory research to alleviate farmers' challenges at the following project sites.

**Table 1. JICA Partnership Projects of Tokyo University of Agriculture and Technology.**

| **Country** & Location | Period mm/yy | Official English Title & (**Running Title of the Project**) | Budget $10^6$ ¥ |
|---|---|---|---|
| **Viet Nam** Thừa Thiên Huế Province | 07/08-06/11 (phase 1) | Improving Rural Living and Nature Conservation by Multipurpose Use of Charcoal and Wood Vinegar in the Bach Ma National Park (**Bach Ma Charcoal Project**) | 50 |
| | 08/11-03/13 (follow-up) | | 30 |
| **Uzbekistan** Farg'ona (Fergana) Province | 09/09-08/12 (phase 1) | Revitalization of the Silk Road Silk Industry in Uzbekistan - Developing a Rural Income Generation Model by the Improved Sericulture in Fergana Valley | 50 |
| Xorazm (Khwarezm) Province | 03/13-09/15 (phase 2) | Technical Cooperation Project for Promotion of the Silk-Road Industry in Uzbekistan - Developing a Technical Transfer Model to Increase Sideline Income of Remote Villages (**Uzbek Silk Project**) | 50 |
| **Brazil** Pará State | 11/11-03/16 (phase 1) | Project for Rural Income Enhancement and Environmental Conservation and Rehabilitation in the Brazilian Amazon through Dissemination and Certification of Successional Agroforestry Systems Developed by the Nikkei Farmers (**Amazon Agroforestry Project**) | 100 |

## 2. Outline of the Projects

In response to the recommendation of Councilor Hatakenaka, University President Dr. Seizo Miyata (term: May 2001- April 2005) ordered a task force for elaborating a JICA Partnership Project [F]. It was four years before the first project was launched in Central Vietnam in 2008 (**Table 1**).

This study takes the form of action research, through implementation of the projects regulated by JICA's project cycle management (PCM) [G] with supervision of JICA Global Plaza office. The authors conducted semi-structured

**Fig. 1. Demonstration of rice-husk charcoal making to local farmers and Bạch Mã National Park rangers.**

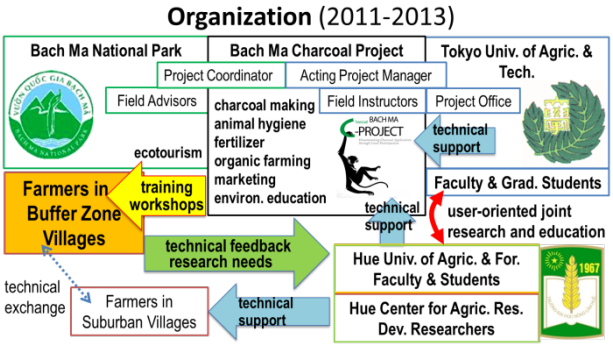


**Fig. 2. Organogram of Bạch Mã Charcoal Project (follow-up phase).**

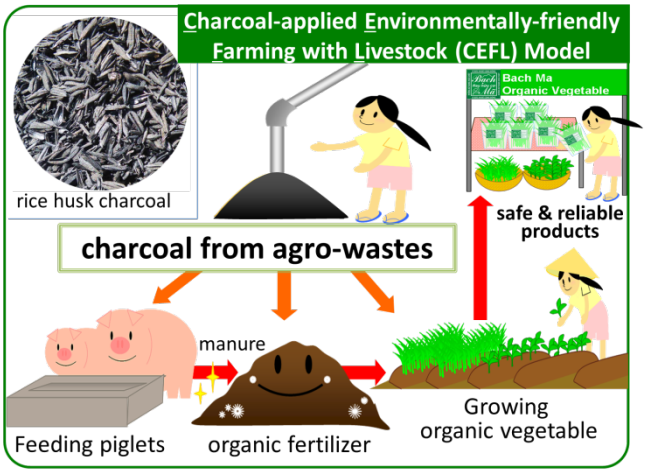


**Fig. 3. CEFL Model proposed by the Bach Ma Charcoal Project.**

interviews, questionnaires and observations to identify beneficiary needs and to evaluate project performance in reference to the project design matrix (PDM) of each project.

## 3. Project Outputs and Outcomes

### 3.1. Vietnam[H)]

This project aimed to improve rural living through sustainable development based upon multi-purpose use of agro-waste charcoal (**Fig. 1**) in the buffer zone of Bạch Mã National Park[I)], Central Vietnam. A goal of the project was that local people live in harmony with the conserved nature of the Park, which was a Vietnamese candidate for a World Natural Heritage site. The project was planned with the vice director of the Park, Mr. Nguyễn Vũ Linh, an awardee of a Japanese Grant Aid for Human Resource Development Scholarship (July 2004-September 2006). Mr. Nguyễn Vũ Linh studied with the first and third authors and received a master degree from the Department of International Environmental and Agricultural Science, Graduate School of Agriculture of Tokyo University of Agriculture and Technology in 2006, when the initial project proposal was submitted to JICA. Our local sister school, Hue University of Agriculture and Forestry, and its partner institution Hue Center for Agricultural Research and Development also participated in the project, with faculty, researchers, students, and model horticulturists working within suburban Hue City (**Fig. 2**).

Using limited information on rural life and production systems within the Park's extensive buffer zone, which consists of a mosaic of different soil, climate, topography and ethnicity types, a baseline survey was conducted in 2009 to clarify the priority of project activities (Bạch Mã Charcoal Project, 2011).

Meanwhile, charcoal kilns were constructed in Khe Su Hamlet, located two km southeast of the Park headquarters, to demonstrate agro-waste charcoal production to farmers. Using charcoal and wood vinegar made from agro-wastes such as rice husks, organic fertilizer production, integrated pest management, and piglet health control were tried out successfully (**Fig. 3**) (Arima, 2013).

Researchers and students of the Japanese and Vietnamese sister schools worked together to address challenges of farmers in the field and laboratory, and presented their research findings to them by lectures and field-day events. Three bachelor theses, six master theses, and numerous articles were published in the process. Recently-weaned piglets demonstrated a significant reduction in diarrhea occurrence: 22.5% of the control group compared to 1.6% of piglets treated with feed mixed with 1% in weight of wood-vinegar-moistened charcoal. The latter showed 440 g per day of weight growth, significantly better than 350 g per day of the control group. New crops including strawberry were introduced for participatory evaluation of their economic potential. In addition, new markets for organic vegetable were developed in nearby cities (Nguyen, 2012). The project received Vietnamese and French TV coverage and newspaper interviews, and participant farmer leaders were invited to three international conferences in Vietnam and Thailand, organized

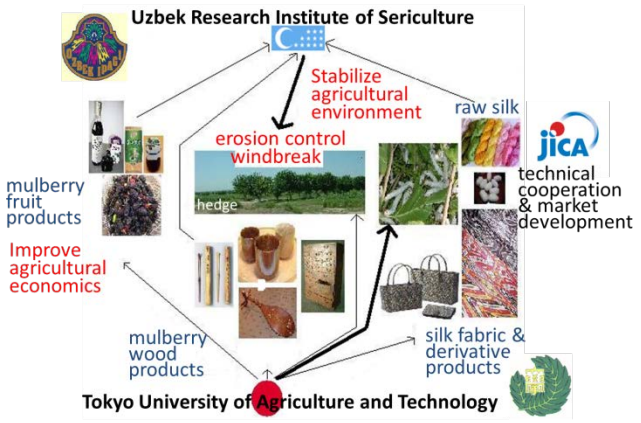


**Fig. 4. Uzbek Silk Project and multipurpose use of mulberry trees.**

by the Asian Development Bank, to share project achievements. By the end of the Project, 155 famers received agricultural training, of which 36 were entitled as master farmers.

### 3.2. Uzbekistan [J)]

Thanks to its unique foundation as mentioned earlier, Tokyo University of Agriculture and Technology holds an extensive network of sericulture scientists and practitioners, as well as related industries. The second author, having long and extensively studied the water quality of the Aral Sea and groundwater in Uzbekistan, witnessed farm soil degradation from salinization that trapped farmers in poverty and poor health. She fell upon the idea of reviving the ancient symbol of the Uzbek Silk Road, the mulberry (*Morus alba*) tree. These trees were once planted along Uzbek roads and farm boundaries like the old 'soil binder' mulberry trees in Japan, for feeding silkworms, and producing fruit, timber, fuelwood and shade (Uzbek Silk Project, 2012). We expected that the introduction of improved silkworm races and the development of multiple products from mulberry trees, such as processed fruit (e.g., jam and juice) and wood crafts made of old trees, would increase local farm income. We hoped this would motivate them to plant and maintain mulberry hedgerows that would also contribute to ameliorating the micro climate of farm lots (**Fig. 4**).

The project is continuing in its second phase in collaboration with Uzbek Research Institute of Sericulture [K) L)], with two sericulture science graduates of our University stationed in Uzbekistan during the spring and autumn breeding seasons. Our faculty in related specializations, such as silkworm disease and plant pathology, are dispatched when needed. With the introduction of Japanese silkworm crossbreeds Shungetsu × Hōshō and Kinshū × Shōwa, and orientations at frequent farm visits, Uzbek farmers familiar with silkworms for generations quickly picked up recommended know-hows (Yamada *et al*, 2012). The

**Fig. 5. Sericulture orientation to Uzbek farmers.**


**Fig. 6. Poster of Handicraft Contest Exhibition in Tashkent.**

**Fig. 7. Uzbek Rural women learning handicrafts (left) and their products sold at JETRO Shop Narita Airport.**

cocoons they produced were spun to 3A-ranked warp certified at the Gunma Sericultural Technology Center in Japan (**Fig. 5**). The project participants yielded 20-40% more cocoon by weight and a 10-20% better unit price, resulting in an increase of one-month's income for an average family farm in the region. The project's successes received attention from the Uzbek Government that resulted in a technical cooperation accord with our University, and a national plan to promote sericulture. Conferences and seminars on this project were held in Tashkent and Tokyo with TV coverage.

In addition, the project collaborated with the Uzbek Business Women Association (BWA) in developing handicrafts made of traditional silk ikat 'atlas' to empower rural women by giving them a side income source. A contest was held in Japan that received almost 300 creative designs

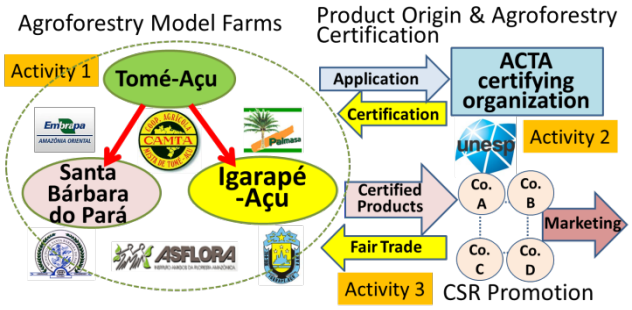


**Fig. 8. Activities of the Amazon Agroforestry Project.**

donated to BWA, and winner exhibitions were mounted at the malls Iias Tsukuba and Sapporo, Gunma Prefectural Government in Maebashi, the Uzbekistan Embassy in Tokyo, and the Ikuo Hirayama International Caravan-Sarai of Culture (ICSC) in Tashkent (**Fig. 6**). The silk products of female farmers have been marketed at the Japan External Trade Organization (JETRO) One Village, One Product Markets at Narita and Kansai International Airports, university cooperative shops and others (**Fig. 7**).

### 3.3. Brazil [M)]

In the Amazon region of South America, Japanese immigrants and their descendants have been farming for more than a century, and a settlement called Tomé-Açu is world famous for its unique agroforestry practice (Anderson, 1990). The Tomé-Açu Agroforestry has been nominated as a 'social technology' by the Brazilian government, and has been the main research topic of the first author for the last two decades (Yamada, 1999). The Amazon Agroforestry Project has a goal of disseminating the nikkei agroforestry methods to small family farms in northeastern Pará State, for improving productivity of their swidden agriculture, so that rapid urbanization causing social instability may slow down (**Fig. 8**).

The first activity of setting up demonstration farms in three locations, JAMIC in Tomé-Açu, Espedito Ribeiro in Santa Bárbara do Pará, and São Brás in Igarapé-Açu, has been realized (**Figs. 9, 10** and **11**). Local farmers participated in land preparation and planting, then cared for plants, and were given weekly or biweekly monitoring visits by our local staff and extension specialists from Tomé-Açu Multipurpose Agricultural Cooperative (CAMTA) [N)]. While demonstration farms are located on poor lateritic (Tomé-Açu) and sandy (Santa Bárbara do Pará and Igarapé-Açu) soils of the region, appropriate fertilizer applications rendered excellent harvests of annual crops, such as watermelon (*Citrullus lanatus*), bean (*Phaseolus vulgaris*) and maize (*Zea mays*), while intercropped tree species grew well in the same field. In Santa Bárbara do Pará, cacao (*Theobroma cacao*) outgrew human height in a year and started bearing fruit. Invited lecturers from Brazil

**Fig. 9. Santa Bárbara do Pará Demonstration Farm (6 months after planting cacao and banana intercropped with watermelon, 2012/09/22).**

**Fig. 10. Santa Bárbara do Pará Demonstration Farm (1 year after planting cacao and banana, with maize seeded for the second time between rows, 2013/03/08).**

**Fig. 11. Igarapé-Açu Demonstration Farm (4 months after planting acerola, cacao, banana, black pepper and gliricidia intercropped with maize; 2013/05/21).**

and Japan provided farmers with information and insights into agroforestry management, fertilizer application, plant protection, pruning and thinning, product processing, and cooperative marketing (**Fig. 12**).

A number of students from various universities in Japan visited our project; some came repeatedly. The students published theses and journal articles related to agroforestry


**Fig. 12. Agroforestry extension specialist from São Paulo giving lecture to small farmers in Santa Bárbara do Pará.**

management and plant nutrient cycling, and presented research results to local farmers at seminars organized by CAMTA and its partners. Recently the project received a visit from three professors from our sister school, São Paulo State University (UNESP), in joint preparation for launching project activities 2 and 3 in this and next school years.

### 3.4. Overall reflections

Two official reports were published on 22nd June, 2011 from the Japan Association of National Universities: 'An Interim Report of The Council on Promotion of Human Resource for Globalization Development' O) from the Office of Prime Minister, and 'Enhancing the Functions of National Universities - Pledge to the People - Interim Report P). The former explained that in modern history Japan both faced and overcame various crises by "seeking international contacts and interactions". It urged Japan to recover its "frontiers to strive for" by "refocusing overseas and reexamining its own identity" to develop sustainable national economy and a happy and spiritually-rich society that would "help Japan gain trust and respect from the rest of the world", and "the very first step and the main objective" for it was "none other than to develop 'global human resources' as Japan's national strategy". For this end, the report recommended that the universities promote strategic research collaboration and student exchange with universities in developing countries. The second report argued that "in order for Japan to play an important role as a member of the international community, it is indispensable to develop talented people by systematically and actively sending researchers and students to overseas education and research organizations, and receiving researchers and students from overseas, to train people who meet the needs of the international community, including international organizations, to support developing countries in creating education and research infrastructures, and to develop people who can take on these responsibilities". Through these initiatives, "the national universities will boost their competitiveness on a global scale by making greater contributions to the international community and human resource development".

The authors believe that the Tokyo University of Agriculture and Technology's integrated research, education and extension initiatives through JICA partnership projects for sustainable development, involving students, researchers, extensionists and administrative staff, were in line with the abovementioned public goals, yet it does not seem to be a popular idea among academic community members, due to absence of a system for aptly evaluating such experiences at the time of hiring or promotion in Japanese research institutes O). Nevertheless, the University's JICA partnership development projects were generally welcomed by the target population in three countries. By the projects' participatory nature, local people enjoyed interacting with us, their foreign partners, and quickly absorbed practical knowledge and skills generated or introduced in the projects. Our students and faculty were also enthused by the exotic environment and close contacts with local people, and above all, by the fact that their research outcomes applied on farms received immediate feedback from the beneficiaries. The agents of JICA, during their project evaluation field visits, frequently praised our academic capability in prescribing solutions to the problems beneficiaries faced. The user-oriented research model in agriculture and sericulture that we used in our international outreach helped us to create an efficient and effective system for generation of knowledge valued in both the scientific discipline and the user environment N), thanks to the interactive education and extension functions involved. However, well-coordinated acquisition of research grants and intervention funding, plus funding for follow-ups and monitoring, still remain challenges. Moreover, in order for the beneficiaries to perpetuate and sustain the fruits of development projects, leadership training and product marketing seem to be the key agendas.

## 4. Conclusion

These authors have demonstrated that, in the age of accelerated globalization, international outreach may promote comprehensive and interdisciplinary research that meets the national and global contributions projected in the Intermediary Plan of Tokyo University of Agriculture and Technology. This outreach and research model may be applicable to other universities engaged in practical sciences as well. The public and donor anticipations for improving international society through the further mobilization of the university's academic resources may lead to increased funding for globally-oriented

participatory endeavors in scientific research.

**Notes** (web links valid as of 2013/08/30)

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