Internal Ex-Post Evaluation for Technical Cooperation Project (SATREPS[1])

conducted by Viet Nam Office: January 2021

Country Name	Establishment of Carbon-Cycle-System with Natural Rubber
Socialist Republic of Viet Nam	

I. Project Outline

Background	Natural rubber (NR), isolated from para rubber trees (Hevea brasiliensis) is a promising plant resource in Asia. The demand for NR was still high due to its specific physical properties that synthetic rubber does not have. As the production of fossil fuel-based synthetic rubber causes enormous carbon dioxide emissions, replacing synthetic rubber with NR is expected to reduce carbon dioxide emissions. On the other hand, NR contains protein substances that cause the latex allergy and disturb chemical modification; therefore, its deproteinization is essential to expanding its use and reducing the risk of protein-caused allergy. Based on the above background, the Government of Viet Nam requested the Government of Japan to implement technical cooperation to establish a carbon-cycle system by development of nanotechnology for production of high-performance NR and highly functional polymer to expand NR usage and establishment of the efficient processing system and usage of wastewater and waste rubberwood under the framework of SATREPS.
Objectives of the Project	The project aimed to enhance the capacity of Hanoi University of Science and Technology (HUST) and Rubber Research Institute of Vietnam (RRIV) on the technologies to realize sophistication and expansion in the application of NR through developing (i) a novel evaluation method of NR, (ii) high-performance rubber, (iii) high functional polymer from NR, (iv) technology to produce bio-fuel from rubber waste woods, and (v) advanced treatment technology of rubber industrial wastewater, thereby contributing to the promotion of researches and development on technologies related to low protein natural rubber in Viet Nam to increase uses of natural rubber to replace fossil fuel-based synthesized rubber. 1. Expected Overall Goal: N.A. 2. Project Purpose: Capacity of Hanoi University of Science and Technology and Rubber Research Institute of Vietnam will be enhanced on the technologies to realize sophistication and expansion in application of natural rubber and environment-friendly natural rubber production.
Activities of the Project	1. Project Site: Hanoi and Binh Duong Province 2. Main activities: (i) Establishment of analysis technology for terminal structure, development of evaluation method, drafting of a new standard for evaluation of low-protein NR; (ii) Preparation of prototype of deproteinized and protein-free NR; (iii) Establishment of rubber nanotechnology; (iv) Development of crushing method suitable for waste wood, selection of degrading microorganisms and enzymes, improvement of degrading microorganism; (v) Development of manufacturing and processing wastewater treatment technology, evaluation of greenhouse gas emission capacity and decomposition mechanism of rubber wastewater. 3. Inputs (to carry out above activities) Japanese Side 1) Experts: 18 persons (3 long-term and 15 short-term) 2) Main equipment: A Nuclear Magnetic Resonate (NMR), a centrifugal machine for a test plant for deproteinization of NR, a pilot reactor for wastewater treatment system, etc. 3) Operation cost Vietnamese Side 1) Staff allocated: 43 persons 2) Facilities: [HUST] Project coordination Office and research facilities at HUST including renovating laboratories, Construction of a new building for the Center for Rubber Science and Technology (CEBER); [RRIV] A laboratory and a site for the pilot scale reactor of wastewater treatment system, Working space for Japanese short-term experts in Binh Duong Province 3) Operation cost
Project Period	April 2011 – March 2016 / Project Cost: (ex-ante) 394 million yen, (actual) 398 million yen	
Implementing Agency	Ministry of Education and Training (MOET); Hanoi University of Science and Technology (HUST); Rubber Research Institute of Vietnam (RRIV)
Cooperation Agency in Japan	Nagaoka University of Technology (NUT); National Institute for Environmental Studies (NIES); Tokyo National Collage of Technology (TNCT); Kure National Collage of Technology (KNCT)

II. Result of the Evaluation

< Special Perspectives Considered in the Ex-Post Evaluation >

For this SATREPS project, PDM (logical framework) was not prepared, and the Overall Goal was not set.[2] According to the terminal evaluation summary, the project expected that the technologies developed by the project be eventually adopted by the rubber industries in Viet Nam in the future, toward the final goal of replacing fossil fuel-based rubber with NR. Based on the above and the framework of the ex-post evaluation of STAREPS projects, this ex-post evaluation regards the following as the Expected Overall Goal, "Researches and development on technologies related to low protein NR are promoted in Viet Nam to increase uses of NR to replace fossil fuel-based synthesized rubber."

1 Relevance
<Consistency with the Development Policy of Viet Nam at the Time of Ex-Ante Evaluation> This project was consistent with Viet Nam's development policies such as the "National Energy Strategy" (2007), which set a target of

[1] SATREPS: Science and Technology Research Partnership for Sustainable Development

[2] The "overall objective" mentioned in the terminal evaluation report was described as a final goal, not a goal for three years after project completion.

5% of renewable energy generation in 2020, and the "National Target Program to Respond to Climate Change (NTP-RCC)" (2008-2020), a comprehensive policy on climate change countermeasures. The Vietnamese Government intended to promote the NR industry as an important agricultural product for export.

<Consistency with the Development Needs of Viet Nam at the Time of Ex-Ante Evaluation>

As mentioned in "Background" above, this project was consistent with the need to develop technology for the production and use of NR to establish a carbon-cycle system. Production of NR was rapidly growing in Viet Nam during project implementation, and value-added processing and waste wood and water treatment of NR were important.

<Consistency with Japan's ODA Policy at the Time of Ex-Ante Evaluation>

This project was consistent with the "Country Assistance Program for Viet Nam" (2009), which held "Stable Supplies for Resource and Energy" (under "Promotion of Economic Growth and Strengthening of International Competitiveness"), "Natural Environment Conservation" (under "Environmental Conservation"), and "Rural Development and Improvements in Livelihood" (under "Improvements in Living and Social Conditions and Corrections of Disparities").

<Evaluation Result>

In light of the above, the relevance of the project is high.

2 Effectiveness/Impact

<Status of Achievement of the Project Purpose at the time of Project Completion>

The project achieved the Project Purpose at the time of its completion. The Outputs of the project, namely, (i) a novel evaluation method of low protein NR, (ii) deproteinized/protein-free NR production technology, (iii) highly functional polymer production technology from NR, (iv) technology to produce bio-fuel from rubber waste woods, and (v) advanced treatment technology of rubber industrial wastewater, were all developed. Also, the Center for Rubber Science and Technology (CEBER) established within HUST is considered as another important output of the project. HUST was allocating budget and personnel for the operation of the center. Two key researchers assigned to CEBER were members of this SATREPS project, and they received scholarships from the project for their Master and Ph.D. study at NUT, Japan.

Concerning RRIV, their research capacity on treatment technologies of wastewater from rubber production was improved, and RRIV was planning to apply for funding from the Vietnam Rubber Group (VRG) to do further studies on treatment technology for wastewater from rubber production plants.

As a result, both of the indicators for the Project Purpose were achieved. Regarding Indicator 1, by involving this SATREPS Project, researchers at HUST collaborated with researchers in Japan and published a number of international papers on NR. Regarding Indicator 2, the Rubber Research Division under the Vietnam Chemical Society was established with HUST as a leading member.

<Continuation Status of Project Effects at the time of Ex-post Evaluation>

The project effects continued to the time of ex-post evaluation. CEBER, as the research hub for low protein NR, and other involved departments under HUST such as the Biology Department and the Department of Environment Technology have continued the researches and started new researches[3] based on the outputs of this project and produced more research papers after project completion. Funding has been obtained from the Ministry of Science and Technology (MOST), MOET, and the National Foundation for Science and Technology Development (NAFOSTED) under MOST. HUST is still a leading member of the Natural Rubber Division of the Chemical Society of Vietnam.

In addition, HUST has secured a budget for operation and maintenance of equipment provided by this project, such as NMR, the test plant for deproteinization of NR, the lab-scale wastewater treatment reactor. The equipment is all in good condition and used for the researches mentioned above.

At RRIV, research on the advanced treatment technology for rubber industrial wastewater was not continued due to their financial difficulty as VRG, its parent company, has been privatized and struggling with the global fall of rubber price. However, follow-up studies on the treatment technology have been conducted by the School of Environment Technology/HUST. Therefore, it does not significantly affect the effectiveness/impact of this project. Regarding the equipment provided under this project, while the pilot reactor for wastewater treatment system is not in use since there is no research that requires this equipment as mentioned above, some analytical equipment such as a gas chromatograph analyzer is used for checking the quality of wastewater from rubber factories as one of the services RRIV provides to rubber companies.

<Status of Achievement for Expected Overall Goal at the time of Ex-post Evaluation>

The Expected Overall Goal has been achieved by the time of ex-post evaluation. The draft national standard for evaluation of low protein NR prepared under the project was adopted by the Vietnam Standards and Quality Institute (TCVN) in 2016 as TCVN 11527:2016. Further, CEBER has made significant progress in upgrading the TCVN standard into a new ISO standard for the evaluation of low-protein NR. CEBER is in the ISO registration process and expects the new ISO standard to be issued in 2021. Besides, CEBER registered with MOST for innovation of the deproteinized NR production technology in February 2018, and it is under the appraisal process.

In terms of commercialization to promote the use of low-protein NR, CEBER has been cooperating with some rubber companies to produce medical gloves of high quality that were highly evaluated by some hospitals using these low-protein NR medical gloves. With the core technology of deproteinization of NR, at the time of ex-post evaluation, Dr. Phan Trung Nghia (ex-Project Manager of this project and the Director of CEBER) was planning to establish a company to start a business with private companies for scaling up the deproteinization process and commercializing medical goods such as medical gloves, contraceptives using protein-free latex. Besides, CEBER has been working with some Japanese companies to develop products further using highly functional polymer originated from NR for products such as automobile parts. Using the deproteinized NR production technology, CEBER cooperated with a Vietnamese private company to conduct further studies on the development of a compound material to produce automobile parts.

[3] Besides the researches mentioned in the table, "Achievement of Project Purpose and Overall Goal" below, CEBER has started quite a number of researches to develop new material from low-protein NR such as sulfurized rubber which will be used in fuel cell and silicalized rubber which is elastic with high tensile strength.

<Other Impacts at the time of Ex-post Evaluation>

No negative impact on the natural environment was observed. Wastewater treatment of the pilot plant is regularly monitored to ensure that the discharge meets the national standards. It is also used as the input data for current ongoing research.

Other positive impacts pointed out by HUST include the following. (a) The capacity was improved among the researchers involved in the project as well as their students, who have been instructed by these researchers to be new researchers on NR. (b) The scientific literacy on the government side has improved as well. (c) After the release of the national standard on the evaluation of low protein natural rubber (TCVN 11527:2016), the Directorate for Standards, Metrology and Quality (STAMEQ)/MOST established a National Technical Standard Committee for rubber and rubber products, and Dr. Phan Trung Nghia was assigned as a member of the committee. (d) Besides, Dr. Nghia was appointed as Head of the Technical Committee for Evaluation of Contraceptive Instrument" under MOST.

<Evaluation Result>

Therefore, the effectiveness/impact of the project is high.

Achievement of Project Purpose and Overall Goal

Aim	Indicators	Results
(Project Purpose) Capacity of HUST and RRIV will be enhanced on the technologies to realize sophistication and expansion in application of NR and environment-friendly NR production.	Indicator 1: Papers are publicized in science journals.	Status of the Achievement: achieved (continued) (Project Completion) By the end of August 2015, 84 papers were publicized in science journals (73 international and 11 Japanese). Of these, 16 were submitted as joint research papers between Viet Nam and Japan. This number of achievements was evaluated by the JST as being "many papers." (Ex-post Evaluation) Papers publicized after project completion include the following. <u>Continuation of the researches based on the ones under this project</u> - 22 papers, including 4 papers of International Scientific Index, on the novel evaluation method of NR (CEBER/HUST) - 10 domestic papers on electricity transmitting rubber, blended rubber, biomass of rubber and biological decomposition of wastewater from rubber production (CEBER/HUST) - (Number unknown) International and domestic papers on the electromagnetic waste absorption materials made from NR <u>New researches based on the research outputs of this project</u> - 2 international papers and 1 domestic paper on the investigation on properties and morphology of modified natural rubber having filler Nano matrix structure prepared by graft-copolymerization with organosilane monomer (CEBER/HUST) - 2 international papers on the characteristics of microbial aggregation of NR (School of Biotechnology and Food Technology/HUST)
	Indicator 2: A natural rubber study division is established in an existing academic society in Viet Nam.	Status of the Achievement: achieved (continued) (Project Completion) Natural rubber division was established under the Chemical Society of Vietnam on 18th of November 2015. School of chemical engineering in HUST became a member of Vietnam Rubber Association on the same day. (Ex-post Evaluation) Natural rubber division has been continued under the Chemical Society of Vietnam. HIST is still a leading member.
(Expected Overall Goal) Researches and development on technologies related to low protein NR are promoted in Viet Nam to increase uses of NR in order to replace fossil fuel based synthesized rubber.	Enhancement of research and development on technologies related to low protein NR in Viet Nam.	(Ex-post Evaluation) achieved - The national standard for evaluation of low protein NR was adopted as TCVN 11527:2016. - CEBER has been cooperating with some rubber companies to produce low-protein NR medical gloves, which was highly evaluated by some hospitals that are using them. - CEBER has been working with some Japanese and Vietnamese companies to develop products further using highly functional polymer originated from NR for products such as automobile parts.

Source: Terminal Evaluation Report; JST Final Report; questionnaire and interview with HUST; telephone interview with RRIV

3 Efficiency

Although the project period was as planned, the project cost slightly exceeded the plan (ratio against the plan: 100% and 101%, respectively). The Outputs of the project were produced as planned. Therefore, the efficiency of the project is fair.

4 Sustainability

<Policy Aspect>

The Government of Viet Nam has committed to contributing to the global effort of the greenhouse gas emission reduction by 8% by 2030. The prime minister approved a national action plan for the implementation of the Paris Agreement on Climate Change. The "Target Program for Climate Change and Green Growth for 2016-2020" was approved by the Prime Minister in 2016, and the Ministry of Natural Resources and Environment plans to renew the program for 2021 and 2025. In a conference to promote the rubber industry's sustainable development, jointly organized by the Central Economic Committee and Ministry of Agriculture and Rural Development (MARD), MARD presented its support for rubber processing technology to focus on the export of rubber products rather than raw material.

<Institutional/Organizational Aspect>

The organizational/institutional arrangements for research activities, as well as social application of the research outputs, have been

secured with CEBER/HUST, which has been a research hub for NR in the northern Viet Nam, as already mentioned. CEBER with three research departments has continued working on the project results, including the development of new material from deproteinized NR, improvement of treatment technologies for wastewater from rubber production, etc.

Regarding RRIV, CEBER has recently restarted its communication with Vice Director of VRG to involve RRIV in their new projects on treatment technologies for rubber industrial wastewater.

<Technical Aspect>

CEBER is rated as one of the key national laboratories, and it has obtained an ISO certificate for a standardized laboratory. Researchers at CEBER have utilized outputs of this SATREPS project to start new projects on rubber material with silica particle, liquid rubber, liquefied epoxy rubber, and catalytic rubber material, transmitting membrane for a fuel cell. By engaging in these new projects and participating in international conferences, the researchers have improved their research capacity and enhance their knowledge of NR.

Although improvement of RRIV's research capacity for treatment technologies of rubber industrial wastewater is limited due to shortage of research funding caused by the global fall of rubber price, researchers at the School of Environmental Technology/HUST have sustained and improved their knowledge on the treatment technologies of rubber industrial wastewater by conducting projects, participating in difference conference and seminars, exchanging with other overseas universities.

<Financial Aspect>

As already mentioned, HUST has been allocating budget for the operation of the equipment provided by this SATREPS project (e.g., 300-400 million VND for NMR every year), and able to mobilize quite a number of financial sources from the government and secure sufficient budget for their researches on NR (e.g., four research grants from NAFOSTED with the amount ranging from 815 million VND to 835 million VND for three years; three research grants from MOET with the amount ranging from 560 million VND to 3,500 million VND for two years). It is expected that in the future, as well, CEBER will be able to secure enough budget for operation and maintenance of the equipment provided by the project, including NMR, from annual budget allocation by HUST, their independent research funded by MOET and MOST, and also joint research and development activities with the private sector including Japanese companies mentioned above.

RRIV has been facing with shortage of funding for their researches. However, the School of Environmental Technology/HUST, which took over researches on advanced technology for the treatment of rubber industrial wastewater, has been able to secure sufficient budget to conduct new projects utilizing research outputs of the SATREPS project and the lab-scale wastewater treatment reactor provided by the project.

<Evaluation Result>

Therefore, the sustainability of the effects through the project is high.

5 Summary of the Evaluation

The project achieved the Project Purpose of enhancing the capacity of HUST and RRIV on the technologies to realize sophistication and expansion in the application of NR. The project's effects have continued, i.e., CEBER/HUST established under this project has served as the research hub for low protein NR, and CEBER and other involved departments under HUST have continued researches based on the project outputs. Collaboration between these research institutions and the private sector for the social application of the research outputs has progressed. The commercialization of the use of low-protein NR, such as medical gloves, has even started. Regarding sustainability, no major problem has been found in any of the policy, institutional/organizational, technical, and financial aspects. As for efficiency, the project cost exceeded the plan only slightly. Considering all of the above points, this project is evaluated to be highly satisfactory.

III. Recommendations & Lessons Learned

Recommendations for Implementing Agency:

(1) Due to some financial difficulties caused by the global fall in the price of rubber, VGR has not allocated a budget for RRIV to continue their research on wastewater treatment technology. However, other technology needs in Viet Nam's rubber industry need to be addressed. For example, the advanced technology developed by this project is used to treat wastewater from rubber latex production. However, only 20% of rubber processed in Viet Nam is latex concentrate (liquid), and the remaining 80% is solid rubber produced from rubber latex. Therefore, further studies should be carried out to make some adjustments to the technology to treat wastewater from solid rubber processing factories. The Vietnamese Government, VRG, and HUST are thus recommended to consider initiating research programs to address such needs. Also, Japanese universities involved in the project could consider cooperating with Vietnamese researchers to localize the technology to meet the demands of the local market.

(2) At the time of the ex-post evaluation, Dr. Nghia of CEBER was preparing to establish a company to start up a business utilizing the deproteinization technology to produce medical gloves and other products from protein-free NR. The establishment of a company is necessary because CEBER is under the management of HUST, a state university, and CEBER is not eligible to sign a commercial contract with a private company. In Viet Nam, research institutes and universities mainly focus on academic works. The collaboration with the private sector to commercialize their research outputs and apply newly developed technologies in real life is still lacking. Therefore, the Vietnamese government is recommended to introduce a model of the industry – academia – government collaboration in Viet Nam. The government's support for university-affiliated venture businesses should be considered to make use of technologies resulting from academic research at national universities and other research institutes.

Lessons Learned for JICA:

This project was designed focusing mainly on research and technology development. Preparation for future social application and promotion for the dissemination of the project outputs was planned, but due to high-end product technology, it was not enough to be feasible. Particularly, the private sector's involvement and ensuring buy-in from the government for the project's outputs were not included. As a result, although RRIV/VRG is under the management of MARD during project time, information sharing with MARD and linkage with the government's programs for the rubber industry's development has not yet been realized.

At the time of the ex-post evaluation, HUST has quite a number of projects on NR funded by MOST and MOET. However, in terms of dissemination and social application, HUST has not been able to link with any government program on rubber industry development

(instead, HUST has managed to carry out the dissemination and social application by cooperating with some private companies). For better promotion of future utilization and dissemination of the project's outputs, aiming at the commercialization of newly developed technologies, the private sector's involvement at the beginning of the project and understanding of the Vietnamese government on the importance of the project is necessary. More outreach activities targeting the private sector and government agencies should have been included in the project. At the end of 2020, VRG asked HUST to support the protein-free rubber technology.

In addition, soon at the project designing stage, some economic analysis or initial market surveying and discussion on proprietary right to consider the potential application/commercialization of the technologies developed by the project should have been considered.

Also, JICA could have encouraged the Vietnamese side to prepare a plan/roadmap of 5-10 years to sustain the project outputs and prepare for future applications of the developed technologies and to have it agreed/endorsed among all the players, including relevant state agencies, involved research institutes and potential private sector partners by the time of project completion.

Photo 1. Medical gloves made from deproteinized NR compared with normal products

Photo 2. Center for Rubber Science and Technology (CEBER) in the campus of HUST