評価調査結果要約表（英文）

Summary of Terminal Evaluation

I. Outline of the Project		
Country： Federative Republic of Brazil		**Project title：** Development of Genetic Engineering Technology of Crops with Stress Tolerance against Degradation of Global Environment
Issue/Sector： Agriculture General		**Cooperation scheme：** Technical Cooperation Projects (SATREPS)
Division in charge： Rural Development Department		**Total cost：**310,000,000YEN
Period of Cooperation	From March 4, 2010 - March 3, 2015 (5 years)	**Partner Country's Implementing Organization：** Embrapa Soybean
		Supporting Organization in Japan： Japan International Research Center for Agricultural Sciences (JIRCAS), The University of Tokyo and RIKEN

1-1. Background of the Project

The population of Brazil is approximately 190 million people and Brazil has land area of about 8.512 million km^2. Coffee, tobacco, and soybean are the main export commodities for Brazil. Especially with respect to soybean, the 2006/7 year's production is 5,840 million tons and accounted for about a quarter of the world's soybean total production. Brazil is the second world soybean producer after America. Consumption of soybean is increasing continuously in the world, especially in China, change of the population growth and dietary habit caused significant consumption rise of soybean. On the other hand,Gradual warming of the earth, first caused by the increasing amount of greenhouse gases with rapid population growth and industrialization has subsequently been raising global problems such as desertification of cropland, reduction of crop yield and security of food and feedstuff. Therefore, development of drought-tolerant soybean plants and maize is now considered as the most important target of such technology because these plants are grown on such a large scale in areas of relatively low rainfall.

This project intends to develop the genetic engineering technology of soybean that is adapted to tolerate drought and heat with the aim to stabilize soybean production in Brazil, in cooperation between Japanese institutions and Embrapa Soybean. The research group at first took steps to isolate useful genes related to environmental stress tolerance and stress-inducible promoters in soybean plants on the basis of research of genes related to environmental stress tolerance and rapidly evolving soybean genome research carried out elsewhere. It selects candidate combinations of such genes and promoter, and then introduces them to the soybean plant. It further evaluates environmental stress tolerance of transgenic soybean plants in greenhouses and under field conditions, with continued result feedback to improve the combination of useful genes and promoters, with the eventual aim to select elite transgenic lines with improved tolerance to environmental stresses.It should be noted that the present project, is one of the business, "science and technology cooperation corresponding to the global issues", with

respect to global issues, including the environment, energy, etc., as well as conduct joint research with developing countries, developing countries it is an object of the present invention is aimed to be made side capacity building.

1-2. Project Overview

(1) Overall Goal

Soybeans adapted to environmental stresses are developed, which contributes to the stabilization of the soybean production in Brazil.

(2) Project Purpose

Genetic engineering technology of soybean with environmental stress tolerance is developed.

(3) Outputs

1) Useful genes related to environmental stress tolerance are identified.
2) Stress-responsive promoters are isolated and combinations with useful genes are optimized.
3) Transgenic soybean lines containing constructs of promoters and useful genes are produced.
4) Transgenic soybean lines with environmental stress tolerance are selected.

(4) Inputs

Japanese side : Japanese Expert: 1 long-term expert and 13 short-term experts in total, Researchers participated in the researches in Japan: 33 persons, Trainees received in Japan: 13 persons, Provision of equipment: around 744,000 US dollars, Local cost expenditure: around 476,000 US dollars

Brazilian side : Assignment of counterparts: 17 persons (at the terminal evaluation), Purchase of equipment: around 1.2 million US dollars, Local Cost: running expenses and scholarships (around 73,765 US dollars), Provision of land and facilities: office spaces for Japanese expert and researchers, biotechnology buildings (existing and newly built), various laboratories, green house, and crop experiment fields etc.

II. Evaluation Team

Members of Evaluation Team	1) Leader: Dr. Narihide NAGAYO, Senior Advisor, JICA 2) Cooperation Planning: Mr. Takumi ADACHI, Advisor, Team 2, Group 1, Rural Development Department, JICA 3) Science and Technology Planning and Evaluation (As observer): Dr. Shuichi ASANUMA, Evaluation Committee, Science and Technology Research Partnership for Sustainable Development (SATREPS) Program, JST/ Professor, Nagoya University 4) Science and Technology Planning and Evaluation (As observer): Dr. Masayuki SATO, Principal Researcher, Department of International Affairs, Research Partnership for Sustainable Development Group, JST 5) Evaluation Analysis: Mr. Isao DOJUN, Consultant, Chuo Kaihatsu Corporation	
Period of Evaluation	From October 19, 2014 to November 10, 2014	**Type of Evaluation:** Terminal

III. Results of Evaluation

3-1. Project Performance

Output 1: Useful genes related to environmental stress tolerance are identified.

Achievement: All indicators of Output 1, which are related with identification of genes involved in regulation of stress tolerance, genes for membrane proteins involved in stress perception, and genes involved in regulation of stress response, have been achieved their targets.

Output 2: Stress-responsive promoters are isolated and combinations with useful genes are optimized.

Achievement: All indicators of Output 2, which are related with identification of stress-responsive genes, identification of stress-responsive promoters, and optimization of constructs of useful genes and promoters, have been achieved their targets.

Output 3: Transgenic soybean lines containing constructs of promoters and useful genes are produced.

Achievement: All indicators of Output 3, which are related with establishment of gene transformation method, introduction of constructs of useful genes and promoters in soybean, and collection of T1 seeds, have been achieved its target.

Output 4: Transgenic soybean lines with environmental stress tolerance are selected.

Achievement: All indicators of Output 4 have been achieved its target.

Project Purpose: Genetic engineering technology of soybean with environmental stress tolerance is developed.

Achievement:

The numerical targets of all indicators for the Project purpose have been achieved and genetic engineering technologies of soybean with environmental tolerance have been developed as explained below. Therefore, it is said that level of achievement of the Project purpose is very high.

3-2. Summary of Evaluation Results

(1) Relevance

The relevance of the Project is high from the following viewpoints. 1) Needs to respond to global climate change, 2) Needs for the development of drought tolerant soybean varieties in Brazil, 3) Needs of the target group (Embrapa Soybean), 4) Relevance to the national development plans of Brazil, and 5) Conformity to assistance policy of Japan to Brazil.

(2) Effectiveness

The Project Purpose is achieved an effective way (effectiveness of the Project is high). Several genetic engineering techniques for producing environmental stress tolerant soybean have been developed. One of the lines generated by Agrobacterium method and tested in greenhouse and field showed very strong character on drought tolerance and also insect pest resistance (insect pest resistance

is not prospected to be expressed, but needed to be analyzed the mechanism and potential furthermore). It can said that this very positive results of the joint research indicate that developed genetic engineering techniques under the Project are very appropriate and effective for developing environmental stress tolerant soybean.

(3) Efficiency

The efficiency of the Project is high in general, despite of longer time required for signing on MTA.

(4) Impact

1) Prospect of achieving the Overall Goal "Soybeans adapted to environmental stresses are developed, which contributes to the stabilization of the soybean production in Brazil."

It is difficult to say that the Overall Goal of the Project will be achieved by 2019 considering time consuming steps required for commercialization of genetically modified soybean. It may take around 8 to 10 years at least after the completion of the Project.

2) Other potential impacts in future

a) Productivity gain for farmers facing reduced production by drought when commercial variety of drought tolerant soybean is developed.

b) Usefulness of knowledge and techniques developed under the Project

c) Usefulness of improved transformation efficiency of Agrobacterium method

d) Usefulness of developed technique on Microarray analysis

(5) Sustainability

Sustainability of the Project is expected to be high in terms of policy, organizational, and technical aspects. Developed genetic engineering technology of soybean with environmental stress tolerance can be utilized in sustainable way by Embrapa for developing drought tolerant soybean variety. However, it is said in general, a large amount of budget is required for biosafety evaluation and deregulation procedures, therefore, it is important to seek partners who could have an interest in commercialization of genetically modified organisms (GMO) of transformed soybean and have financial capacity.

3-3. Factors that promoted realization of effects

(1) Factors concerning to the implementation process

None

(2) Factors concerning to the implementation process

1) The Japanese and Brazilian research institutions have carried out research activities with clearly demarcated roles on research themes based on trust relationship. 2) Good communication between Japanese and Brazilian researchers and good coordination for carrying out research activities.

3-4. Factors that impeded realization of effects

(1) Factors concerning to planning

None

(2) Factors concerning to the implementation process

1) Long term needed to sign on MTA (Material Transfer Agreement), 2) malfunction of cooling s ystem for greenhouse which was constructed with JICA budget, and 3) long term needed for purchasing reagents necessary for research activities.

3-5. Conclusion

The Joint Terminal Evaluation Team has confirmed that indicators of all outputs and the Project Purpose areachieved. As the results of the research activities, scientific knowledge and information on genetic engineering technology of soybean with environmental stress tolerance have been accumulated and various useful techniques have been established. A line of transgenic soybean showed higher drought tolerance and insect pest tolerant characters as a result of field experiment. There are some more types of gene which will be tested at greenhouse and field levels. It is expected that more varieties of soybean may have environmental stress tolerant characteristics. Although, there are several steps and challenges in future for developing commercial variety which can be used by farmers, it can be said that developed technology under the Project is very useful not only for basic research but also research activities toward developing soybean commercial variety.

3-6. Recommendations

3-6-1. Recommended actions to be taken by the Project in the remaining cooperation period

(1) Acceleration of finalization of MTA

3-6-2. Recommended actions to be taken after the termination of the Project

(1) Budget allocation for purchasing and installing cooling system for greenhouse

(2) Important points toward commercialization

1) Strategy for commercialization, 2) Continuation of cooperative relationship, 3) Analysis of potential on insect resistant expression in soybean which SAT5 gene is introduced, 4) Field experiments at locations where drought climate condition is occurred more frequently, and 5) Biosafety risk assessment and deregulation.

3-7. Lessons Learned

(1) Contributing factors that brought significant research results

Good relationship through past joint research and definition “roles and responsibilities” between Embrapa Soybean and Japanese institutions contributes to obtaining significant research results.

(2) Acceleration of MTA procedure

It is necessary to concern about MTA procedure for keeping from delay so that negative effect about progress of project can be reduced when similar project or joint research is carried out in future.