Summary Results of the Terminal Evaluation Study

I. Outline of the Project	
Country: Indonesia	Project Title: The Project for Producing Biomass Energy and Material through Revegetation of Alang-alang (*Imperata cylindrica*) Fields
Issues/Sector: Environment/Agriculture	
Division in Charge: Economic Development Department	
	Estimated Total Cost: Approx. 318 million yen
Period of Cooperation: July 2016 to July 2022	Related Organizations in Indonesia: Indonesian Institute of Sciences (LIPI) *now National Research and Innovation Agency (BRIN)
Related Organizations in Japan: Kyoto University	

1-1. Background of the Project

Indonesia is an island nation whose area is approximately 1,890 thousand km^2 with a population of 273 million (2020). Its economy has grown steadily with an annual rate of 5-6% in the past ten years, which contributed to the remarkable increase in Nominal Gross Domestic Product (GDP) from USD 285.9 billion in 2005 to USD 1.06 trillion in 2020, becoming one of the largest economies in ASEAN countries. While the country enjoys steady economic growth, Indonesia also faces emerging challenges, including ensuring energy security for a rapidly growing population while reducing the Green House Gas (hereinafter referred to as "GHG") emissions and achieving sustainable growth.

The government of Indonesia has been making efforts to enhance the utilization of alternative and renewable energy sources to lower the dependence on oil. The New Paradigm of National Energy Policy towards Energy Security and Independence (Directorate General of Electricity, March 21, 2014) states that new and renewable energy sources have been an urgent national issue as the emission of GHG has rapidly increased in recent years due to an increase in fossil fuel consumption and destruction of forest resources. To address these challenges, the government drafted a roadmap for the energy transition to achieve net zero-emission by 2060.

The tropical rainforest resources started to be exploited massively and intensively after the Second World War. Large parts of deforested areas are dominated by perennial grass represented by *Imperata cylindrica*, known as alang-alang in Indonesia. This invasive grass weed grows extremely well on poor soil and is resistant to drought and fire. Therefore, it has spread widely not only in Indonesia but also in tropical and subtropical regions all across the world. The area of deteriorated grasslands mainly composed of *I. cylindrica* is reported to be more than 10 million hectares in Indonesia. Managing such deteriorated grassland has become a major global issue for environmental conservation. The former Mid-term Development Plan of Indonesia (RPJMN 2015-2019) also stated the conversion of marginal land (including alang-alang grasslands) to more productive landscape (e.g., farmland, artificial forest, etc.) as a priority which needs to be addressed in Indonesia from the standpoint of agricultural development and environmental conservation.

Against this background, the Project for Producing Biomass Energy and Material through Revegetation of Alang-alang Fields (hereinafter referred to as "the Project") was formulated and has been implemented as a SATREPS project since July 2016 as a collaboration project between Kyoto University and Indonesian Institute of Sciences (hereinafter referred to as "LIPI", now the National Research and Innovation Agency, hereinafter referred to as "BRIN"). The purpose of the Project is to develop technologies to produce energy crops, especially sorghum, in alang-alang fields and produce biomass which could be used as biomass energy and materials.

1-2. Project Overview

(1) Overall Goal

A model of the establishment of sustainable society by innovative bio-energy and material technology is developed in Indonesia.

(2) Project Purpose

Technologies for producing sustainable biomass energy and material utilizing alang-alang fields are developed.

(3) Outputs

1. Methods of fertilizer application for plants producing high-energy biomass are established.
2. Protocols to convert degraded land to revegetated land are established.
3. Grass biomass plants with higher-heating value are developed by breeding.
4. Environmentally friendly technologies to produce lignocellulose-based materials using grass plants are established.

(4) Inputs[1] (as of Terminal Evaluation)

Japanese Side:

a. Dispatch of 13 short-term experts (researchers) and one long-term expert (project coordinator)
b. Provision of machinery and equipment: Japanese Yen (hereinafter referred to as "JPY") 105 million
c. Local operational costs: JPY 50 million
d. Training opportunities in Japan: 10 counterpart (hereinafter referred to as "C/P") researchers

Indonesian Side:

a. Counterpart personnel assigned to the Project: 75
b. Provision of office space for Japanese experts
c. Renovation of 6 research facilities and provision of a generator
d. Local operational costs: Indonesian Rupiah 5.9 billion (approximately JPY 50 million)

[1] When calculated as 1 Indonesian Rupiah=0.00888 Japanese Yen (as of May 2022)

II. Evaluation

Terminal Evaluation Team		
Name	Position	Affiliation
<Japanese side>		
Ms. Mihoko SAITO	Team Leader	Deputy Director, Agricultural and Rural Development Group1, Economic Development Department, JICA
Dr. Shuichi ASANUMA	Research Evaluation	Special Advisor, Economic Development Department, JICA
Ms. Ai ISHITOBI	Evaluation Analysis	Consultant, Tekizai Tekisyo LLC
<Indonesian side>		
Prof. Dr. Sulaeman YUSUF	Team Leader	Senior Researcher, Research Center for Applied Zoology, BRIN

Period of Evaluation: 10 May - 27 May 2022	Type of Evaluation: Terminal Evaluation

III. Results of Evaluation

3-1. Achievements

(1) Output 1: Achieved

Through the identification and utilization of effective technologies to monitor the nutritional status of sorghum and changes in soil microbial community through metagenomic analysis of soil microbiota, the team demonstrated that sorghum cultivation in alang-alang fields is possible without significantly harming the environment and with a reduced amount of fertilization, less than recommended by the Ministry of Agriculture. The team also developed the fertilization method, including mycorrhizae inoculation, to increase the productivity and drought tolerance of sorghum. Hence, the results of Output 1 contributed to the development of fertilization methods for environmentally and economically sustainable biomass production in alang-alang fields, as well as the reduction of CO_2 emission through reducing fertilization. Therefore, the team achieved the expected outputs of Output 1 by the time of the terminal evaluation.

(2) Output 2: Achieved

Output 2 successfully demonstrated that sorghum cultivation can increase soil microflora and plant species diversity in alang-alang fields with compost application and intercropping. The team also demonstrated that the productivity of biomass sorghum (including those developed by Output 3) can be largely increased (by 20-60%) in the alang-alang fields at the model sites through the fertilization methods developed by Output 1, which do not negatively impact soil and plant diversity. The team also developed and shared information on plants that can be intercropped with sorghum in marginal lands on the website of C/P[2]. These results provide important scientific evidence that alang-alang fields can be converted into revegetated lands, including through intercropping of various plants with sorghum, and were compiled as a technical guideline. Therefore, the team achieved the expected outputs of Output 2.

[2] http://webgis.satreps.lipi.go.id/

(3) Output 3: Achieved

By the time of the terminal evaluation, the team selected and bred two mutant sorghum lines[3], which are higher biomass sorghum lines (36% increase) with higher lignin content (27% increase), one of whose lines is also highly drought tolerant, compared with existing varieties[4]. Therefore, the team successfully developed the sorghum lines suitable for cultivation in alang-alang fields and suitable for efficient bioenergy production. The team also identified rice genes effective in increasing lignin content (53% increase) and high heating value lignin structure (G type: 27% increase, H type: 8 times) and selected biomass sorghum lines with the obtained gene information. Seeds of the screened sorghum lines were amplified. Therefore, the team achieved the expected outputs of Output 3.

(4) Output 4: Achieved

Through the activities of Output 4, the team developed production methods to produce biomaterial and bio-energy (i.e., particleboard, molding, bio-pellet and bioethanol) utilizing sorghum bagasse, sorghum juice and alang-alang. Physical properties of particleboards composed of wood and sorghum bagasse were clarified. Through the techno-economic analyses of sorghum pellets and particleboards, the production and commercial feasibility of these products were examined. Through Life Cycle Assessment (LCA) analyses, the team showed that all outputs can contribute to the reduction of CO_2 or increase CO_2 fixation by using biomass sorghum. Therefore, the team achieved the expected outputs, including the establishment of environmentally friendly technologies to produce biomass materials.

(5) Prospects for achieving the Project Purpose

By the time of the terminal evaluation, all indicators of the Project Purpose were achieved. That is, (1) steady production of biomass crops cultivated in deteriorated alang-alang fields was demonstrated in the project and model sites, (2) feasibility for commercial manufacture of biomass pellets and lignocellulose-based materials was examined, (3) reduction of CO_2 emission by utilizing biomass energy and materials produced through a total system of revegetation of alang-alang degraded fields was estimated, and (4) comprehensive technical guidelines for producing sustainable biomass energy and material utilizing alang-alang fields were compiled and shared among stakeholders both in public and private sectors. Thus, the evaluation team concluded that the Project achieved the Project Purpose.

3-2. Evaluation Results by Six (6) Evaluation Criteria

Results of Terminal Evaluation by the six (6) evaluation criteria are summarized below.

(1) Relevance: High

The Project is aligned well with the Indonesian national development policies and relevant sector policies (energy policies/roadmaps and an agricultural master plan) and can contribute to achieving the targets. Besides, the Project meets the needs of the Indonesian society (e.g., conversion of marginal lands to productive lands, sustainable production of bio-energy) and BRIN (one of whose missions is achieving a sustainable

[3] Konawe Selatan (KS) and Sorghum Malai Mekar (SMM)

[4] Average value of the sampled varieties tested.

environment). In addition, the approach of the Project (e.g., transfer of technologies in which Japan has comparative advantages and appropriateness of the selection of the target group, which has a top-level research institute that can have a capacity to implement a SATREPS project) was also appropriate.

(2) Coherence: High

The Project is in line with the Japanese Country Assistance Policy for Indonesia set in August 2020, which states the development of low-carbon technologies as one of the strategies to assist in building capacity to address issues of the Asian region and international society. Besides, by restoring degraded land and soil and increasing the share of renewable energy through the promotion of bioenergy, the Project can contribute to the achievement of the Goal 7 and 15 of the Sustainable Development Goals (SDGs). By developing technologies to reduce CO_2 emission or increase CO_2 fixation through the revegetation of marginal lands and the utilization of sorghum as bioenergy and biomaterials, the Project can also contribute to achieving the target of the Paris Agreement.

(3) Effectiveness: High

As stated above, the Project Purpose was achieved at the time of the terminal evaluation. At the same time, to ensure the steady production of sorghum biomass at a larger scale in the longer term to promote social implementation, it is imperative to develop a technology to cultivate sorghum in a larger area and on a larger scale with different climatic and soil conditions. In addition, for the project results to be fully utilized by the public and private sectors, it is essential to make sure that the technical guidelines and other outputs are shared and understood among relevant stakeholders while informing them on how these outputs can contribute to the promotion of bioenergy as well as reduction of CO_2 emission, which can be achieved without posing a threat to national food security.

(4) Efficiency: Relatively High

While most inputs, such as the assignment of human resources, provision of machinery and equipment, training opportunities, local operational costs and the office space for program staff, and renovation of research facilities, were well utilized to achieve expected results. While the COVID-19 pandemic and the delayed procurement of reagents negatively influenced the project implementation, since all Outputs were achieved by the terminal evaluation, efficiency was assessed as relatively high

(5) Impact: Prospects of achieving the Overall Goal are difficult to judge at the time of the terminal evaluation. Some positive impacts of the Project are observed and can be expected in the long term.

While the terminal evaluation mission understands that the Overall Goal aims to apply technologies developed by the Project to both policies and businesses to increase biomass production using alang-alang fields, since the current indicators of the PDM (version 2.1) do not reflect the goal, it is difficult to judge the prospects of achieving it with these indicators. Furthermore, to achieve the goal, additional activities would be required, such as (1) further research to sustainably produce biomass at a large scale, (2) submission of policy recommendations to promote the utilization of the Project outputs by the government and (3) promoting

collaboration among the government, industry and academia. Several positive impacts of the Project were (and expected to be) observed, such as capacity development of researchers of both countries and C/P institutions, contribution to the local economy and ripple effects of the project outputs on other countries and regions with alang-alang fields. No negative impact of the Project was observed by the terminal evaluation.

(6) Sustainability: Relatively High

While the promotion of bioenergy and bioproducts is highlighted as one of the national priorities of Indonesia, there are no concrete action plans and strategies to develop value chains of biomass. Thus, the policy and institutional sustainability of the Project is moderate - relatively high. At least minimum resources to continue research activities will be secured by BRIN, and the continuation of some research activities will be financially supported by the Sorghum Advanced Utilization Technical Research Association in Japan. On the other hand, to conduct further research activities, C/P researchers need to apply for competitive research funds. Hence, financial sustainability is relatively high. From the organizational aspect, the ownership of the C/P team is very high. They are permanent staff of BRIN, and their turnover rate is very low. Besides, a research organization on agriculture and food, which used to be under the Ministry of Agriculture and joined BRIN, can support the research activities of the Project. Hence, organizational sustainability is high. From the technical aspects, appropriate technologies were transferred to C/P, and they were shared and utilized within C/P. Developed technologies and research findings were compiled as the technical guidelines and scientific articles. Machinery and equipment provided through the Project were well operated and maintained. Therefore, technical sustainability is considered to be high.

3-3. Major supporting factors in achieving the Project Purpose

(1) Factors related to planning

- The long-standing relationship (academic exchange) between LIPI/BRIN and Kyoto University for more than 30 years led to the efficient implementation of the project activities. Some research members have studied at Kyoto University, and the Project benefited from the active participation of those researchers.
- The project coordinator made a significant contribution to coordinating activities and facilitating communication among the team. His contribution to the project implementation was highly appreciated by the team.
- The Project utilized yeast strains from the Indonesian Culture Collection (InaCC) to produce bioethanol from sorghum juice as well as a machinery of the centre (a deep freezer) for the research activities. The capacities of the centre established by a previous SATREPS project[5] were well utilized for the research activities.

(2) Factors related to the implementation

- The strong leadership of the project leader contributed to the effective implementation of the Project,

[5] The InaCC was established by another SATREPS project named "the Development of Internationally Standardized Microbial Resource Center to Promote Life Science Research and Biotechnology" (2011-2016).

in spite of various challenges during the pandemic. The project manager also actively communicated with all Output leaders and other team members to implement the Project effectively.

- As a part of measures to address the COVID-19 pandemic, the team introduced an online meeting tool (Zoom) and actively promoted communication among all project members.
- The assignment of the technical advisor, who has a high level of technical expertise in the academic subjects of the Project and understands both Indonesian and Japanese cultures and language, was critical for the efficient project implementation.

3-4. Major hampering factors in achieving the Project Purpose

(1) Factors related to planning

- No major issue was identified.

(2) Factors Related to Implementation

- The COVID-19 pandemic delayed and negatively affected the project implementation in many ways.
- The prolonged procurement of chemical reagents, some of which took more than a year, also hampered the efficient implementation of the research activities.

3-5. Conclusion

At the terminal evaluation, the joint terminal evaluation team confirmed that the Project has achieved its Project Purpose as described in PDM. Through the four Outputs, the Project has developed technologies for producing sustainable biomass energy and material utilizing alang-alang marginal lands. These technologies include monitoring of plants and soil conditions, fertilization methods which optimize the harvest of sorghum while considering the environmental sustainability and conservation of biodiversity. The Project has also selected sorghum varieties with higher lignin content, and produced mutated sorghum line which has higher lignin and biomass content. These varieties are currently being prepared for the variety registration at MOA and it is expected to be available for future production in few years time. Furthermore, the Project has developed the technologies to produce various biomass materials using sorghum, including bio-pellets and particleboards, which exhibit high market potentials.

The Project was timely and highly relevant to the Indonesian government's policies to achieve low-carbon society. The government has set the target to achieve zero-emission by 2060, with a view to meet the international commitments including the Paris Agreement and SDGs. It is expected that the demands for the biomass material, especially the bio-fuels for co-firing with coal in the power generation industry, will continue to increase in the future. In order to accelerate the production of biomass, it is essential for the Indonesian Government to develop strategies to produce and supply biomass, including sorghum. The technologies developed under this Project could contribute to the government efforts in increasing the use of bio-energy, by highlighting the comparative advantage of sorghum as an efficient source of biomass.

The Project contributed to the human resource development, especially increasing the capacities of young researchers in both Indonesia and Japan. Trainings in Japan were received very positively and all participants reported that the trainings were very beneficial to enhance their research and managerial capacities. Through

the close collaboration between BRIN and Kyoto University, research results were published as 18 papers to academic journals. The Project also produced technical guidelines, policy briefs and techno-economic analysis report to communicate some of the results achieved by the Project to wider audience including the government agencies and private companies. Further dissemination of these outputs are expected in the future to maximise the usage of technologies developed under the Project. SATREPS Conference, which was held six times during the Project period, was a useful tool to disseminate the information about the research. The network established through the SATREPS Conference could be utilized in the future to continue sharing the results of the Project to related stakeholders.

The partnership with private sector was actively explored during the Project period. Working with private sector, including the power generation company, biomass material producers and users, allowed the Project to examine the technical and commercial feasibility of the developed technologies. Further collaboration with the private sector is required in the future to meet the increasing demands of biomass from the companies, which was also confirmed during the terminal evaluation.

Some activities of the Project were delayed due to the global outbreak of COVID-19 pandemic and the Project period was extended for one year in order to achieve the Project Purpose. Despite the significant challenges, the research teams in both Indonesia and Japan have continued the research activities remotely by maximizing the online communication tools. Communication between Indonesian and Japanese research team was intensified after the mid-term review, and such effort contributed to improve the coordination among four Outputs and led to the realization of the Project Purpose.

3-6. Recommendations

(1) Recommendation 1 : Provide policy recommendations to the Indonesian Government on utilization of sorghum with higher lignin content and higher biomass content.（To BRIN and Kyoto University）

The government of Indonesia is aiming to achieve zero-emission by 2060, in order to meet the targets set out by international commitments, including the Paris Agreement and SDGs. In order to achieve this goal, the Indonesian government is currently promoting the use of biomass, especially through co-firing with coal. While the co-firing roadmap designed by ESDM aims to use 8.9 million tons of biomass per year by 2030, the current production of biomass is only 2 million tons per year. In this regards, is essential to increase the production of biomass to reach the target in the co-firing roadmap.

Although there are general policies to promote renewable energy, particularly bio-energy, concrete action plans or strategies to develop the value chains of biomass, including production, processing and transportation, are not yet in place. In order to promote bio-energy, it is essential for the Indonesian government to develop action plans/strategies to produce biomass, including cultivation of energy crops such as sorghum.

The technologies developed by the Project to produce sorghum with higher lignin content and higher biomass content would be an important inputs for the government when designing such plans/strategies. In this regard, **the evaluation team recommends that BRIN, together with Kyoto University, should produce policy recommendation to the Indonesian government on utilization of sorghum with higher lignin content and higher biomass content as efficient source of biomass energy.**

The policy recommendation should include evidence why sorghum produced under this Project has high potential to contribute to the promotion of bio-energy as well as reduction of CO_2 emission, by using data compiled by the Project. It should also emphasize that the production of sorghum will be done in the marginal lands and there will be no competition with the agricultural land, thus do not pose threat to national food security.

The evaluation team proposes that the policy recommendation to be produced by BRIN, with the close co-operation with Kyoto University, by the end of 2022. It should be submitted to all related ministries, including MOA, ESDM and KLHK.

(2) Recommendation 2: Develop the technologies to scale-up the production of sorghum with higher biomass productivity, by continuing the joint research.（To BRIN and Kyoto University）

While the field experiments at the model sites were implemented in 0.5 to 1 hectare of land, LCA conducted under this Project showed that sorghum need to be grown in 100,000 hectare of land in order to replace 5% of coal with biomass.

In order to achieve the scenario identified by LCA, it is necessary to develop technologies to expand the sorghum production sites and enable sorghum to grow in various soil and climatic conditions of alang-alang marginal lands. Information on such technologies is also required for the government and private sector to accurately estimate the production cost and design their policy/investment decisions.

Since the technologies developed by the Project were already verified at the laboratory level, **the evaluation team recommends that BRIN and Kyoto University to continue conducting the joint research and establish technologies to produce sorghum in larger, more diverse areas. Sustainable production management (i.e. fertilization in large area, avoiding risks of monocropping) should also be established in order to maximize the harvest of sorghum while minimizing the negative environmental effects.**

(3) Recommendation 3: Secure the resources for continuous research for large-scale social implementation. (To BRIN and Kyoto University)

To scale up the Project's results to larger and more diverse areas, the resources will be required to continue the researches in both BRIN and Kyoto University. Some activities which require additional resources include the fields experiments in eight locations across Indonesia to collect data necessary for the variety release after the registration of new sorghum variety developed under this Project. Additional resources need to be secured to develop technologies to scale up the sorghum production as well.

In this regard, **the evaluation team recommends to BRIN and Kyoto University, as much as possible, to continue their efforts in securing the resources to continue research for social implementation.** Resources from the private sector should be actively explored, following the example of The Sorghum Advanced Utilization Technical Research Association in Japan, which obtains research funding from the private sector who are interested in using sorghum as biomass.

(4) Recommendation 4 : Establish the multi-stakeholder platform to strengthen partnership among academia, government and private sector. (To BRIN, Kyoto University and Indonesian government)

In order to convert the vast alang-alang marginal lands into production sites of biomass, strong political will and the intervention from the government will be required. At the same time, large-scale revegetation will require investment and cooperation from the private sector. To apply the technologies developed under this Project to the larger social implementation, it is essential to encourage collaboration among the government, industry and academia.

In this regard, **the evaluation team recommends to establish a multi-stakeholder platform to strengthen partnership among government, private sector and academia.** The platform could utilize the network established through the SATREPS Conference. The platform should be established in 2023, with the membership including, but not limited to, the following parties.

- Government agencies (the Ministry of Agriculture, the Ministry of Energy and Natural Resources and the Ministry of Environment and Forestry)
- Academia (BRIN, Kyoto University)
- Private Sector (both Indonesia and Japanese companies)

For the establishment of the platform, the evaluation team suggests the following milestones:

- By the end of this Project period (July 2022) : List of potential members is proposed by BRIN and Kyoto University.
- By the time of post-evaluation (2025) : Regular meetings/discussions are taking place and the role of each member is defined to promote biomass production using sorghum with higher lignin and higher biomass content developed under this Project.

The Sorghum Advanced Utilization Technical Research Association could also provide useful insight of such partnerships, and collaboration with the Association should also be considered.

(5) Recommendation 5 : Revise the indicators for the overall goal. (To BRIN and Kyoto University)

The overall goal of the Project should be achieved by the Indonesian C/P three years after the completion of the Project (July 2025). Current overall goal in PDM is "A model of the establishment of sustainable society by innovative bioenergy & material technology is developed in Indonesia.", and it is important to have a common understanding on what should be achieved by July 2025.

According to the discussion at the terminal evaluation, a long-term objective of this Project is to utilize the newly bred sorghum varieties with higher lignin and higher biomass content to revegetate the marginal lands including alang-alang fields, and contribute to increase the biomass production in Indonesia. With this in mind, the team understood that "A model of the establishment of sustainable society by innovative bioenergy & material technology is developed in Indonesia." means that technologies developed by the Project are applied and/or become available to be applied to both policies and commercial activities. With this assumption, **the evaluation team proposes to revise the indicators of overall goal, as described in the following table.**

Current Indicators for Overall Goal (PDM ver. 2.1)	Proposed Revision
1. Strategy and action plan for establishing a sustainable low-carbon society referring to the technologies developed by the Project is compiled by Indonesian government and shared among stakeholders both in public and private sectors.	1. The policy recommendations/policy briefs are produced by BRIN, with close cooperation with Kyoto University, and reflected to government policies/action plans/strategies/projects concerning biomass production for energy and material as well as marginal land development.
2. The comprehensive technical guidelines are reflected on government policies concerning biomass production for energy and material as well as marginal land development.	
3. Business models/plans for manufacturing of biomass pellets and lignocellulose-based materials are prepared by LIPI and shared with private companies.	2. Business models/plans for manufacturing of biomass pellets and lignocellulose-based materials are prepared by private companies, taking into account the technologies and economic analysis produced by the Project.
None	(new) 3. Multi-stakeholder platform to promote production and usage of sorghum is established and functioning.
None	(new) 4. New varieties of sorghum with higher lignin and higher biomass content developed by the Project is registered by MOA and become available for the future production.

3-7. Lessons Learned

(1) Ensuring inter-linkages and coordination among different outputs

In SATREPS project, each Output often covers different research topics and it is common that a group of researchers is assigned to each Output. This Project too, has assigned the group of researchers to four Outputs, and each team has advanced their research activities according to PDM. At the mid-term review of this Project, the evaluation team has pointed out that "cooperation over different Outputs is not close enough[6]", and it may "disturb understanding of the Project Purpose and conducting harmonized research activities as whole team of the Project towards its accomplishment". Following the recommendations from the mid-term review, the project team worked closely to ensure coordination among different Outputs. These efforts included regular online meetings to share progress and challenges. As a result, inter-linkages and coordination among Outputs were improved significantly in the latter half of the Project, which contributed to achieving the Project Purpose.

While it is common for SATREPS projects to focus on each research topics in the first half of the Project, it is desirable to emphasize the importance of coordination among different Outputs from the early stage of the Project. In this regard, JICA could advise the project team to consider how they can ensure inter-linkages and coordination among different Outputs at the Detailed Planning Survey, so it will be reflected in PDM and considered from the beginning of the Project.

[6] Mid-term evaluation report, page 25.

(2) Detailed design of social implementation at the beginning of the Project

Social implementation is one of the most important aspects of SATREPS projects, since SATREPS projects aim to address the specific challenges faced by the developing countries. While a large part of SATREPS projects focuses on developing new technologies, it is essential to design the detailed vision of the social implementation at the beginning of the Project.

In this Project, various researches were conducted to turn marginal lands including alang-alang fields into production sites for biomass. A number of analysis, including LCA and techno-economic analysis, were conducted in order to consider the feasibility of the social implementation. These activities were useful to produce policy brief and provide some evidences to the policy makers.

It would be important for JICA to support the project team to design detailed images of social implementation at the beginning of the Project, so there would be enough time to develop the way forward to realize the social implementation.

(3) Working together with coordinators with technical expertise

This Project showcased a good example of Japanese project coordinator and Indonesian technical advisor working closely to facilitate the project implementation. The Indonesian technical advisor has studied in Japan and had technical expertise on the subject. Together with the Japanese project coordinator, they have successfully facilitated the communication between Indonesian and Japanese team, which contributed to achieve the Project Purpose.

SATREPS projects usually assign Japanese project coordinators who works with C/P. However, assigning a research/technical advisor from a partner country could be very beneficial for project implementation, especially to facilitate communication and support various arrangements including the procurement of equipment and reagent.

(4) Detailed planning for the timely procurement of equipment and reagent

It is a common challenge of SATREPS projects in many countries, including Indonesia, to procure equipment and reagent in timely manner. There are various reasons to cause delays in procurement process, including the customs procedures, transportation and related administrative works. The delay in the procurement of equipment and reagent was also observed in the first half of this Project. It was improved later in the Project, thanks to the detailed planning of the activities and the support from the project coordinator and the technical advisor.

In SATREPS projects, it is common to procure various equipment and reagent, and the detailed planning is essential to make sure these items arrive on time. In the case of Indonesia, procurement process of equipment could only start after receiving the official requests from the Indonesian Government through the submission of application form (so called “A4 form”). Thus, it is strongly recommended to JICA to actively reach out and support the Indonesian C/P to communicate with the relevant ministries and request them to submit the application form (A4 form) to the Embassy of Japan in Indonesia. This should be done immediately after the signing of R/D, since the whole application process may take few months. Furthermore, a list of equipment to be procured should be examined thoroughly by implementing agencies of both Japan and partner country in advance, so the procurement process could start immediately after the beginning of the Project.

(5) Importance of mid-term review

This Project conducted a mid-term review in 2019 and clarified the role of each Output to achieve Project Purpose and Overall Goal. As a result, PDM was revised to clarify the activities and avoid duplications among Outputs. This exercise of revisiting the Project with the third party was effective to improve the Project structure and contributed significantly to design the activities of the latter half of the Project. While it is not obligatory to conduct the mid-term review under the current monitoring scheme of JICA's technical assistance projects, it is strongly recommended to JICA to conduct the mid-term review, especially for SATREPS projects, since each Output's activities may proceed independently due to the nature of researches. The mid-term review could provide an opportunity for the Project team to identify the challenges and adjust the remaining activities as required to achieve the Project Purpose by the end of the Project.