Journal of STI Policy and Management

Publication details, including instructions for authors and subscription information: http://www.stipmjournal.org/

Outcome and Impact Based Evaluation of Research Program Implementation: A Case of Indonesian Public Research Institute

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Version of record first published: 15 July 2018

To cite this article: Hermawati, W., Siahaan, S., Rosaira, I., Manalu, R., and Santoso, A. (2018). Outcome and Impact Based Evaluation of Research Program Implementation: A Case of Indonesian Public Research Institute. *Journal of STI Policy and Management,* 3(1), 17–34

To link to this article: http://dx.doi.org/10.14203/STIPM.2017.132

ISSN 2540-9786 (Print); ISSN 2502-5996 (online)

Accreditation Number: 21/E/KPT/2018

JOURNAL OF SCIENCE, TECHNOLOGY, AND INNOVATION POLICY AND MANAGEMENT (STIPM JOURNAL), Volume 03, Number 01, July 2018

FOREWORD by EDITOR-in-CHIEF

We are glad to announce that the journal of *Science, Technology, & Innovation Policy and Management* (STIPM Journal) Vol 3, No. 1, July, 2018 is ready for public reading and views. The journal itself focus on STI policy and management.

The aim of this issue is to combine the various perspectives of R&D management and STI policy. Original papers as well as case studies-based research are presented to the readers.

STIPM Journal is an online research journal managed by the Center for Science and Technology Development Studies, Indonesian Institute of Sciences (PAPPIPTEK-LIPI). This journal is a blind peer reviewed journal, which provides free access to research thoughts, innovation, and original discoveries that are needed mostly by the research scholars. In this edition, the STIPM Journal contains six articles dealing with science, technology and innovation policy and management written by scholars from Japan, Thailand, India and Indonesia.

The first article, entitled *India's science, technology and innovation policy: Choices for course corection with lessons learned from China* by **G.D. Sandhya.** In this paper, an attempt has been made to look at how comprehensive India's STI policies with regard to policy components; a roadmap; and strategies for execution and boldness in terms of identifying and recognising the failures and recommend major structural changes. What is intended is to understand the relationship between the domain of S&T policy and expected outcomes; the mismatch between the policy expectations and outcomes. An attempt is being made to identify possibility for correction by taking lessons from other economies, such as China.

Second article were written by **Wati Hermawati, et al.,** entitled *Outcome and impact based evaluation of research program implementation: A case of Indonesian public research institute.* This article relates to outcome and impact based evaluation (OIBE) of a research program implementation at an Indonesian public research institute (PRI) 'A'. The major funding for PRIs in Indonesia comes from government. It is very essential, therefore, for various parties including policy makers to be informed about meaningful and relevant evaluation of the outcome and impact of such PRI to the welfare of the people, to technology development and innovation, and to the policy improvements in significant ways.

Hidenori Shigeno, et al., presents the third article, *Internal innovation capability and ICT use in the innovation process from the view of connectivity in Japanese SMEs.* This article discusses how internal innovation capability such as the technological level and R&D (Research and Development) contributes to the innovation and how it is promoted by ICT use. Using the survey data of about 650 SMEs (Small Medium Enterprise) from all over Japan, this study constructs two models with ICT or without ICT and focuses on how SEMs (Structural Equation Modeling) obtain information from external linkages and the role of ICT in the innovation process

The effect of team diversity in cross-functional teams for enhancing research commercialization: An experience of Thai public research institute is an article presented by **Warangkana Punyakornwong**. This article discusses the effect of team diversity and institutional factors in terms of top management support and incentive system on the number of license agreements in the context of the National Science and Technology Development Agency (NSTDA) in Thailand.

The fifth article entitled *A contextual scientometric analysis of Indonesian biomedicine: Mapping the potential of basic research downstreaming* is presented by **Ria Hardiyati, et al**. The article discusses how to obtain a rich contextual overview of the development of biomedicine research in Indonesia, for example in the context of the down-streaming potential of research publications. The results of text data processing using a computational model and bibliometric analysis will provide a richer contextual picture as a proxy to reveal the potential for down-streaming of basic research.

Final article was compiled by **Kristiana, et al.,** with the title *The value chain analysis to support industrial cluster development of oil palm-cattle integration in Pelalawan Regency, Indonesia.* This article discusses the value chain of oil palm-cattle integration proggram and to formulate reinforcement programs to develop cluster of oil palm-cattle integration with industrial cluster approaches. Among the five products from the oil palm-cattle integration program, the liquid organic fertilizer and solid manure are more profitable than the primary product of husbandry: the beef. Nonetheless, both products are highly dependent on the beef cattle existence. In other words, if the business of manure and liquid organic fertilizer are not profitable, the business of beef cattle will also fail.

In addition to all articles that presented in this volume, we also would like to thank the authors, editors, and reviewers who have worked very hard in this edition. We hope that all articles featured in this edition will be useful for the reader.

Jakarta, 16 July 2018

Editor-in-Chief

JOURNAL OF STI POLICY AND MANAGEMENT

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STI POLICY AND MANAGEMENT

Journal homepage: http://www.stipmjournal.org

STIPM STI Policy and Management

Outcome and Impact Based Evaluation of Research Program Implementation: A Case of Indonesian Public Research Institute

Wati Hermawati[*], Saut Siahaan[*], Ishelina Rosaira[*], Radot Manalu[*], and Agus Santoso[*]

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ARTICLE INFO

Article History:
Received : 9 March 2018
Revised : 24 May 2018
Accepted : 08 June 2018
Available online : 15 July 2018

Keywords:
Outcome
Impact
Public Research Institute
Evaluation
Indonesia

ABSTRACT

This paper relates to outcome and impact based evaluation (OIBE) of a research program implementation at an Indonesian public research institute (PRI) 'A'. The major funding for PRIs in Indonesia comes from government. It is very essential, therefore, for various parties—including policy makers—to be informed about meaningful and relevant evaluation of the outcome and impact of such PRIs to the welfare of the people, technology development and innovation, as well as to the policy improvements in significant ways. The mixed methods with good blend of qualitative and quantitative analysis is used in the case study of a competitive research program (CRP) of PRI 'A'. The case study demonstrates that the outcomes and impacts of CRP are found in the form of economic, social, and environment improvements in the communities; managerial change and innovation of technology and process for SMEs as well as improved existing policies; and increased capabilities of researchers at PRI. Recommendations of this study is that PRI'A' should improve their research management and policy, strengthen collaboration with firms, including more human resources mobility required to facilitate research collaborations and co-production process, and to have clear guidelines and targets of outcomes and impacts for their research results.

I. INTRODUCTION

Public Research Institutions (PRIs) are one of the two main actors (universities and research institutes) in the public research system and are considered as primary tools for government in enhancing knowledge, technology and innovation as well as to spur national economic development (OECD, 2011; 2017; Mazzoleni & Nelson, 2007; Mulyanto, 2014; Intarakumnerd & Goto, 2016). In Indonesia, activities of PRIs are those performed by public institutions, such as the Indonesian Institute of Sciences (LIPI), National Nuclear Energy Agency of Indonesia (BATAN), Indonesian National Institute of Aeronautic and Space (LAPAN), and Agency for the Assessment and Application of Technology (BPPT) that are mostly publicly owned or operated to a large extent on government funding for their activities. In developed countries, PRIs also have a role in

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http://dx.doi.org/10.14203/STIPM.2017.132

providing direct R&D supports to business firms and public authorities (Maass, 2003). Many experts also agreed that their role remain critical for countries' innovation and economic performance through their activities in creating, discovering, using and diffusing knowledge and technology (OECD, 2011; 2017; Mazzoleni & Nelson, 2007; Suzuki, Tsukada, & Goto, 2014). It has become very clear that research institutions need to play a more active role in their relationship with industry in order to maximize the utilization of their research results as well as in the realizing of economic, social, environmental and cultural benefits for the community development.

Previously, research institutions were perceived as a source of new ideas, and industries maximized the use of these ideas. However, nowadays public funded research and development activities are increasingly expected to be relevant to public issues such as people's quality of life, environmental conditions, support policy formulation, and improvement of existing industries. In the economic sector, the emphasis and ways that PRIs help industry change over time and vary across countries, as they are an integral part of the national innovation systems (Intarakumnerd & Goto, 2016; Cohen, Nelson, Walsh, 2002).

PRIs can play important roles not only in creating new knowledge and transfer it to firms, but also acting as 'intermediaries' (Lente, Van Hekkert, Smits, & Waveren, 2003). More specifically, Dodgson and Bessant (1996) proposed that PRIs perform particular activities on bridging the demand (user needs) and the supply side (resources) in innovation processes, such as articulation of specific needs and bridging links with outside knowledge system. Roles of PRIs in linking various actors such as users, producers, and other stakeholders could be expected even more to boost innovation.

Assessment of the effectiveness of a public funded research program and project by the number of articles published in peer-reviewed journals, possibly accompanied by the number of downloads of research outputs have been practiced in Indonesia as well as in many countries (Befani, 2016b; Guinea et al., 2015; Mackenzie & Hearn, 2016; Piric & Reeve, 1998; Stern et al., 2012). However, it is no longer sufficient to only produce outputs of what public funded research projects aim to achieve. Nowadays, it is often expected that research, especially publicly funded one, should have a wider impact and oriented towards problem-solving of their stakeholders, such as business, community, academia, and public policy, as well as building researchers' capacity, that the intervention as 'cause' has an 'effect' (Boaz, Fitzpatrick, & Shaw, 2008).

Stern et al. (2012) state that best results of public funding institute often makes policy makers wish to replicate, generalise and scale-up. They also need to accumulate lessons for the future. Whereas Borgonovi, Anessi-Pessina, & Bianchi (2018) point out that performance is expressed in terms of the amount of resources collected and allocated (again input-related performances) as well as actual numbers of beneficiaries reached (often operationalized as the ratio between the pursued objectives of policies and the actual results of implementation). As such, the justification for public investment in R&D should be subject to scrutiny and reviews of their effectiveness in producing the impacts or providing outcomes, including inputs for public decision making.

Evaluation of public funding in R&D programs and activities aims to determine both costs and benefits as well as to justify public investment in R&D. Evaluation can also be used to justify the efficiency and effectiveness of the R&D public investments. Public funded R&D institutions mostly strive to provide excellent results and fulfill their stakeholders' needs (industry, community, and government), to manage programme effectively, as well as to make a better quality of people's life.

By using case studies from one of the public research institutes (PRIs) in Indonesia, this paper discusses several questions. What are the outcomes and impacts of the Competitive Research Program (CRP) of this PRI? How is the OIBE conducted in this PRI. Many of the most important outcomes of this public R&D funding are in the form of new knowledge, skills, experience, which are considered as intangible

and unquantifiable (Siahaan, Hermawati, Rosaira, Manalu & Santoso, 2017). These benefits may not be realised or be counted to the success of the institution as well as its partners and stakeholders. For many parties including government and funding agencies, OIBE plays a key role in the drive for better evidence on results and development effectiveness. They give answers to important questions about whether the interventions work well or not, whether they make a difference or not, since the research results (products or services) were adopted by the recipients. Leeuw & Vaessen (2009) even stated that OIBE produced information that was relevant from an accountability perspective; they disclosed knowledge about the (societal) effects of the programs that could be linked to the (financial) resources used to reach these effects. Informed decision makers on whether to expand, modify, or eliminate projects, programs, and policies are linked to this point.

It is, therefore, the objective of this evaluation to determine whether a particular reseach program of a public funding research institute 'A' has an impact, and also to quantify how large that impact is, particularly impacts on final beneficiaries that resulted from a development intervention of CRP. Are the impacts oriented towards problem-solving of their users or stakeholders? It also includes explaination on how policy interventions contribute to an effect so that lessons could be learnt.

The scope of this evaluation can be identified through questions such as: the impact of what, on what and for whom? OIBE is used in this research for evaluating the CRP of PRI 'A'. The measurements of research results also include the achievement or changes in skill, knowledge, attitude, behaviour, condition, or life status for program participants.

The CRP was started in 2002 and considered as a special corporate program of PRI "A" with top down approach. This program adopted multi-years, multi-institutions, multi-dimensions and multi-disciplines schemes. Funding of this research program mostly comes from government, with a small amount also comes from industries. The research program conducted by more than 25 research centers under PRI 'A' with the total researchers and technicians of more than 300 were involved in this program.

II. METHODOLOGY

Focus and scope of the study covering outcomes and impacts based evaluation of 188 CRPs completed within 2010 until 2014, as shown in Appendix I and II.

Three case studies are also presented in this paper and considered as best practices of CRP. OIBE intended only for research program with projects that produces products or services, and does not include citation and scientific writings such as books or articles published in peer-reviewed journals. The program impacts evaluation was conducted by comparing condition of the beneficiaries—before and after the project was implemented.

A. Mixed Methods

The research used 'mixed methods', which was the combination of qualitative and quantitative approaches in a single evaluation (Creswell, 2009). Almost all quantitative assessments have some measure of qualitative analysis, at least by reading the project documents and additional information from interviews. The call for mixed methods generally comes from proponents of qualitative approaches. The use of qualitative data included a wide range of activities, not just having insights from the results of discussions and interviews with project staff and various beneficiaries, experts, and other stakeholders in the field, but also reading of project documents, project reports, and literature related to the projects. The visits and re-visits used a semi-structured questionnaire to identify the users and benefits of the program/projects as well as impacts generated from the program/projects.

The quantitative data was either in the form of a number of products/services provided by the projects, a number of beneficiaries of the projects, or a number of networking created by the projects. Those quantitative data analysis were informed and enriched by qualitative insights through interview will provide more deep and meaningful results of analysis (Figure 1). It

was, therefore, a mixed methods approach that focused on delineating outcomes and exploring impacts which should be more appropriate for evaluating a PRI's outcomes and impacts. OIBE involves data collection, recontacting people/ experts over time, clarifying what has happened to the recipients of the projects and determining whether these impacts spread widely towards continues improvement in the community/ industry or provide feedback to policy makers.

Detailed evidence gathering of program's impacts were determined by each project conducted in the fieldwork. The fieldwork lasted five months, involving a team of six researchers and two assistants. The researchers interviewed the management team of the project, beneficiaries, as well as counterpart of the projects. Focus group discussions among management team, beneficiaries, policy makers at district government and other stakeholders related to the project were also held in the fieldwork and/or local government office.

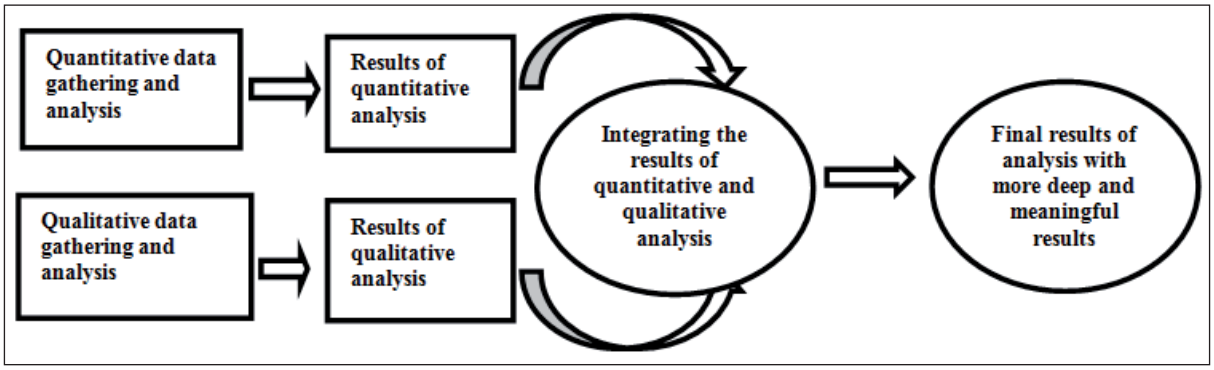
B. Document Review

We analyzed existing documents to gain information on the process of research as well as outputs, outcomes and impacts that were resulted from 188 projects. Documents consisted of summary reports from the coordinator of the projects, progress reports and end research reports that was submitted by the research project principals in between 2010 and 2014. We also reviewed notes from partners of the projects, report or minutes of the meetings and discussions that were submitted to the Coordinator of CRP. There were two different reviewers from the research team independently, reviewed the documents, actors involved, context, processes used, and content for development and implementation. In total, 238 documents were reviewed.

C. Key Informant Interview

We also assessed 38 transcripts of key informant interviews with management team and users or beneficiaries of the CRP. Interviews took place between March 2017 and August 2017. Face-to-face semistructured interviews were conducted for about 30–60 minutes. In-depth interviews were conducted on their site as part of the evaluation process and in order to have more understanding about the outcomes and impacts resulted from the CRP of PRI 'A'. Main contents of the interview were related to implementation processes, the changes occured as results of the project, benefits to the users, and the wider impact to the surrounding including policy contents or the impact or causal effect of a project on an outcome of interest. Interviews were digitally recorded after completing the consent process and transcripts were reviewed independently by two members of the research team. Themes were categorized based on contents, actors and partners, process, outcomes and impacts. Results were compared across data sources (document reviews and interview transcripts) to ensure accuracy.

In summary, methods used in this research were (1) documentary study including scanning of the CRP and their project documents, research reports, etc.; (2) questionnaires distribution to



Source : Adopted from Creswell, 2009.

Figure 1. Mixed Method Approach

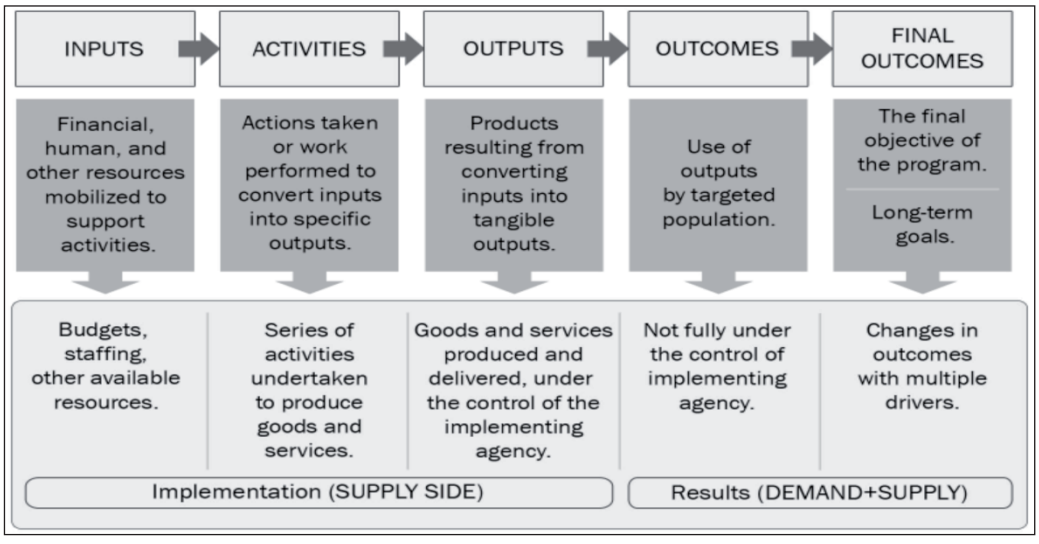
former project coordinators and principal investigators/ principal researchers; (3) extensive and intensive fieldwork/observation (surveys, interviews, etc.) including key informants in depth interviews with beneficiaries (community, SMEs, district government and industry) and management interviews (high eschelon/top decision makers at PRI 'A', coordinators and researchers; (4) quantitative analysis of project monitoring data; (5) compilation of quantitative and qualitative data analysis; (6) focus group discussions; and (7) writing research report.

III. OUTCOME AND IMPACT BASED EVALUATION: AN ANALYTICAL RESEARCH FRAMEWORK

Within the scholars themselves, there is much debate about what OIBE means (Hearn and Buffardi, 2016; Shalock, 2002). However, in this paper, OIBE refers to outcome and impact based evaluation. Outcome evaluation is a finite and often measurable change or as direct results of the project or activity. The reach of an outcome will be pre-defined and the scope will be similarly limited, while impact evaluation is principally concerned with final results intervention. It refers to much broader effect or changes that occur within the beneficiaries of the projects (it can be community, industry or other stakeholders) and can be conceptualised as the longer term effect of an outcome.

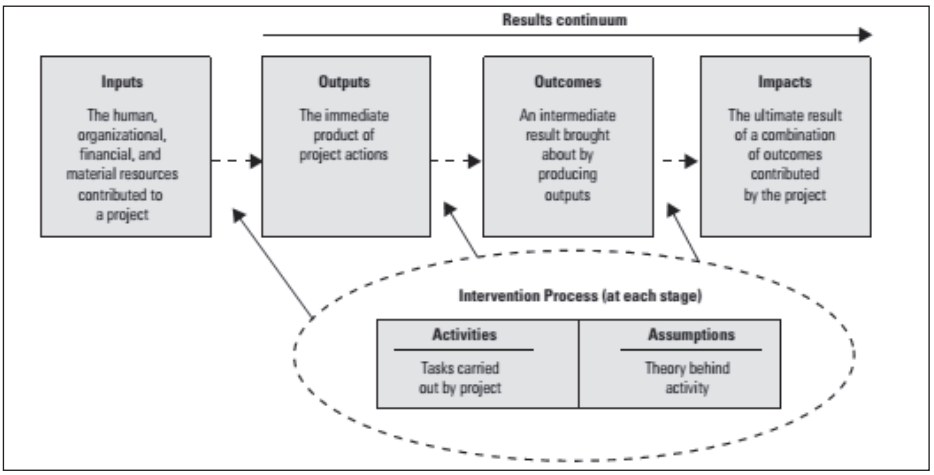
The impact evaluation of a particular intervention can be long term, direct or indirect, positive or negative, primary or secondary changes and can be treated as a singular focus or as a complementary element to outcomes assessment (Shalock, 2002; OECD-DAC, 2010; Leeuw & Vaessen, 2009; Peersman, et al., 2016). 'Outcome' that result in impact is different from 'outputs', which are the direct products resulting from the implementation of intervention activities or projects. Meanwhile, 'outcomes' are the intermediate-term changes in the target group(s) who have been engaged in the intervention and which precede, and are usually a pre-condition for, impact to occur (Shalock, 2002; Peersman, et al., 2016).

Outputs, on the other hand, are more suitable for those performance management systems that aim to provide feedback with minimal lag from actual performance because outputs can usually be detected, measured, and reported more instantly and easily than outcome information (Peersman, et al., 2016; Gertler, Martinez, Premand, Rawlings, & Vemeersch, 2011; and Borgonovi, et al., 2018) as shows in Figure 2. Interventions process can happen in every stage of a research project as shown in Figure 3.



Source: Adopted from Peersman, et al. (2016); Gertler, et al. (2011)

Figure 2. General process of the researh project



Source : Leeuw & Vaessen, 2009

Figure 3. Intervention process of research project

In the case of PRIs, the difference between outcomes and impacts can be illustrated by using research results of PRI 'A', as shown in Table 1.

OIBE of PRIs should demonstrate the value of government investment as well as improved programme effectiveness (Mackenzie & Hearn, 2016; Peersman, et al., 2016). Martin (2011) mentioned several boundary concerning OIBE activities, such as the activities are certainly costly and require various indicators (also need to be regularly updated). However, the total cost of OIBE projects should be clearly less than the benefits of the projects. OIBE is also considered as a labour intensive activity and requires extensive professional expertise.

It is, therefore, balancing cost and sophistication in developing impact assessment that is really needed. Impacts may begin to occur at all stages of the research cycle and thus it is worth planning from the conception of the research project, how impact activities will be carried out and how data from these will be captured. Douthwaitea, Kuby, van de Fliertc, and Schulzd (2003) mentioned that the evaluator also seeks to establish plausible links between the project outputs and developmental changes, such as poverty alleviation.

In the OIBE, evaluators should make a judgement about causal relationship between the observed outcomes and impact and the programme, such as to what extent the programme contributed to the changes (Rogers, 2008; 2012). OIBE also attempts to answer questions related to descriptive, casual inference and evaluative (Rogers, 2014; Stern et al., 2012). Basic questions for OIBE of PRI 'A' in this article are mostly adapted from Befani (2016a), namely:

Tabel 1.
Difference Between Outcomes and Impacts

OUTCOME	IMPACT
Short-term and intermediate changes	Long-term changes
Example: A new formula of organic fertilizer resulted from a research project is accepted by the farmers.	*Example*: After a year using this organic fertilizer, the harvest of *padi* (rice) is increasing and increases land fertility.
Effect on participants either at the individual or group level	Effect on the entire community, society at large, or industry at national scale
Example: Individual farmer or a farmer group who uses that organic fertilizer takes part in socializing green environment and organic food campaign.	*Example*: improved the quality of farmer's life and the environment as well as increased food stock (rice) in that area.

1) What has changed and for whom?
2) How and how much the programme activities contributed to those changes?
3) What is the overall merit and worth?

To answer all questions, qualitative and quantitative data are needed which describe the process of programme implementation and adoption by the users, including the contexts and networks by which the programme/projects were conducted.

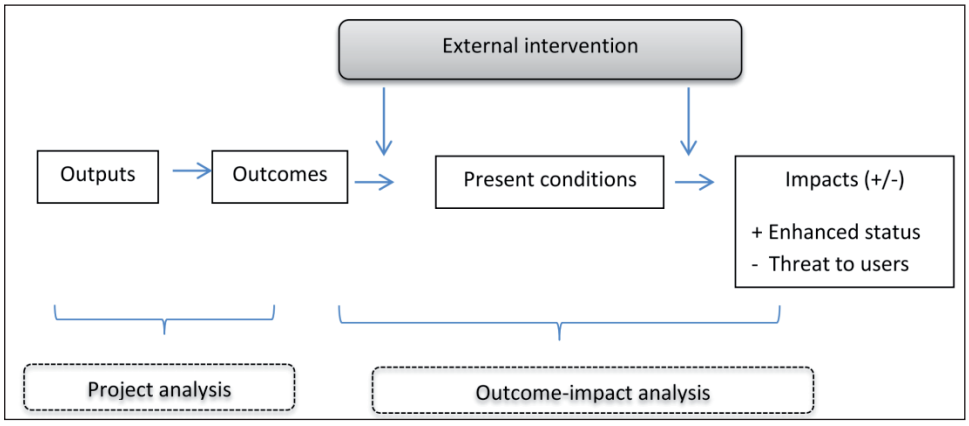
Further description of impact evaluation is related to the impacts produced, or contributed, by an intervention and seeks to determine what difference the intervention has made. Impact evaluations can be undertaken for formative purposes—to improve an intervention, or for summative purposes—to inform decisions about whether to continue, discontinue, replicate or scale-up an intervention (Rogers, 2014).

An impact evaluation addresses three types of questions: descriptive questions that asks how things are or what has happened; causal questions that asks whether or not, and to what extent the intervention brought about the observed changes; and evaluative questions that asks about the overall value or the intervention taking into account intended and unintended impacts, the criteria and standards established upfront and how these should be weighted and synthesised (Shalock, 2002). Figure 4 provides the component of impact evaluation framework for this study.

IV. RESULT AND DISCUSSION

The major advantage of CRP case study is that it is based in hard data from completed projects where it is much easier to identify performance indicators since the outcomes are "visible", although the major problem is in the tracking of all research documents, due to the fact that the research has long been done. The research revealed that the overall CRP's research has produced outputs in the form of 728 scientific papers; 27 registered patents; 108 prototypes/ new formula/new technology packages/new raw materials; 50 development models; and 36 policy recommendations for high level policy makers (regional and central government), as shown in Table 2.

Among 188 projects of CRP, there were only 25 projects which were potential in generating impacts. These projects have produced about 12 prototypes/pilot of technologies; 9 registered patents, and 5 new products (lab scale). However, due to the delay in responding to or supporting the research results by their R&D institutions, the potential impacts never occurred. Their outcomes are mostly at the end stage towards commercialization or adopted by the users (communities or small scale industries). The lack of awareness from the institution also causes the outcomes to deteriorate, and weak quality of decisions were made, so the information about those outcomes remains unknown or unused by the users.



Source: Adapted from Leeuw and Vaessen, 2009

Figure 4. Component of impact evaluation

Table 2.
Results of the Competitive Research Project of PRI 'A' – Year Completed within 2010-2014

INPUTS →	PROJECT ACTIVITIES →	OUTPUTS →	OUTCOMES --- IMPACTS		
			Immediate	Short-term	Long-term
Year start 0	1 - 3	1 – 3	1 - 3	4 – 5	6 +
Existing scientific knowledge; Researchers' capacity in PRI 'A' and its partners; Skills capacity of the technicians in the projects; Others supports from management and its partners, such as: funding and R&D Facilites .	Basic research; Applied/development research; Training; Advocation; Coordination/collaboration; Dissemination; Evaluation; Project Management;	Better trained farmers, craftsmen, and other users; Research network and collaboration; 728 Scientific publications and more than 500 other noon academic documents; 27 Registered Patent; 50 Development models; 36 Policy briefs - for regional and central government; 108 Prototypes, Pilot Plants, Demonstration Plots,etc.	Research Institute gained: Increased researchers and technician capacity; Improved scientific knowledge; Expansion of the network; Increased trust from the users.	Research environment improved; The trust from outside parties, such as donors, industries and local governments increased; Continuation of the research.	Research conditions, management, and funding improved; Provision of good quality of researchers and technicians; Continuation of the research.
			Communities/House-holds/ SMEs and industry/other stakeholders gained: Improved practitioners' capability.	Increased productivity of SMEs; Increased income of community; Job/employment creation.	Better economic and social prosperity; Better environment.
			Government gained: Improved policy/regulations; Creation of new programs.	Improved regulations; Creation of new program.	Improved policy/ regulations; Creation of new program.

Many experts admitted that channels of interaction between PRIs and industry should be developed. Among them, Dutrenit, De Fuentes, & Torres, (2010) state that channels of interaction are important for learning purposes. They suggest that the channels related to joint and contract R&D, property rights, and human resources are the best, as they have a higher impact on long-term benefits for firms. These schemes should be developed further at PRI 'A'.

After having in depth interview with the project management and visited potential project sites, we found that 3 projects have been adopted by the users/communities for more than 5 years. Consequently, they have been generating some impacts to the users. This is also stated by Bovaird (2014) that a longer time frame is usually needed to see the impact, because evaluating how the programs have affected the outcome takes time. In this study, impact of the projects is particularly assessed from the economic, new technology/ new knowledge, social, and change management point of view. Impacts from economic point of view was determined by wheather the research results can substitute import products; saving cost (efficiency); fulfill market demand; provide alternative raw materials for industry; and creating job in the community. Category of new technology/ knowledge impact is determined not only by the resulting a new technology product, but also by innovative product; improved research facilities; improved industrial technology capability; and new knowledge. Social and evironmental impacts are determined by whether the project results improve environment or lessening pollution; create security in the community, particularly after the adoption of the technology. Change organization impacts are determined by renewed structure of the user's organizations/SMEs/industries; creating new partners both from users' and PRI's point of view.

The three project case studies below are considered as sustainable projects that have impacts on the users (community, SMEs, and local government). The impacts of the projects to the institution are mostly in the form of increased researcher's capability, expanded institutional and individual (researcher) networks, and improved existing knowledge. Evaluation pertaining to outcomes and impacts of the three projects will be discussed below as case studies of this paper, including what are supporting and barrier factors in generating impacts as well as what are the policy implications generated from this projects.

A. Case Studies' Findings

Case 1: Selected land microbes project for sustainable agriculture and environment.

The research project of selected land microbes' treatments for sustainable agriculture and environment was started from 2008 until 2010. The project was managed by two researchers (a Ph.D and a Master) and two technical assistants from Biology R&D Institution of PRI 'A'**.** This research was fully funded by the government. Results of this research were: a new formula of liquid and granule organic fertilizers, innovative equipment/technology for blending the organic fertilizer, patent, and a policy recommendation for regional development. The new formula and blending equipment for organic fertilizer were adopted by various farmers' groups in more than 5 districts in West, Central, and East Jawa Provinces, East Kalimantan and West Sumatera Provinces.

In the introduction stage of the research results, the researchers developed good network with local government and local leaders, especially to convince farmers in that area to replace chemical fertilizer with organic one. The researchers held two to three times training for selected farmers and developed a demonstration plot as a sample of rice fields or fruits plantation with organic fertilizers. Until 2016, more than 2,000 farmers have attended the training courses held by this project, mostly on producing liquid organic fertilizer.

The outputs of this project among others are registered patent, prototype of organic fertilizer as well as it's blending equipment, scientific papers and reports. Support also came from almost all local governments in the implementation area of the new formula of organic fertilizer. The local governments also provided special funding support to the farmer groups for constructing organic fertilizer equipments, as well as provided travel support to farmers groups for attending the advance training in managing and producing organic fertilizers as well as organic rice/fruits in Biologi R&D Center at Cibinong, Bogor, West Jawa Province.

Types of outcome from this project among others were:

4) New formula of liquid and granule organic fertilizer;
4) Prototype of equipment/technology for blending the organic fertilizer.
5) Two firms has licensed the patent of liquid organic fertilizer,

After having three to five years' experience in using this fertilizer, the local government and farmers in that area admitted that:

1) The farmers have new knowledge and skills in making organic fertilizer;
2) Increased fertility of their rice fields and agriculture land;
3) Rice stock in that area increased;
4) Better condition of environment and surrounding;
5) Farmers can save their spending (40%) from buying chemical fertilizers;
6) Household's income increased (on the average about 30%);
7) They build a cooperative for managing their business including organic fertilizer that they produced.

Knowing so many benefits of producing and using organic fertilizer resulted from CRP of PRI 'A', a new regulation pertaining to land management and organic agriculture were launched by the local government in Wonogiri, Ngawi, and Gresik District. This new regulation will help organic fertilizer of PRI 'A' continues to exist and be used by the farmers. Appendix III provides summary of the OIBE results of the case study 1.

Case 2. Community empowerment at the Village Level through biotechnology application of the cattle breeding

The research project was conducted by three researchers (two Ph.D. and a Master) and two technical assistants from Biotechnology Research Center of PRI 'A'. Project site was located in Siak District, Riau Province and Malinau District, East Kalimantan Province. Siak and Malinau are two districts that have big areas of palm oil estate and palm oil production. Almost all households in these areas also have small palm oil plantation and cattle or buffalo. The local potentials have

brought researchers to develop an integration program of palm oil plantation and cattle breeding, especially for cow or buffalo in these two pilot projects (Malinau and Siak).

Main program for this CRP was a nursery research on cattle through artificial insemination held in 2009–2011. At the beginning, two farmers groups each in Siak and Malinau were selected as a pilot project. In implementing the research results, researchers from PRI 'A' cooperated with local government and universities, particularly in cattle feed processing and treatment. More than 200 cows had artificial insemination in Siak and Malinau during 2019–2011. Within 4 years, population of cows increased almost double. Health quality of cattle was also improved. As a consequence of this, price of cow was also became higher.

Type of project outputs were as follows:

1) Prototype of artificial insemination;
2) Prototype of cattle feed proccessing technology from palm midrib;
3) New formula of organic fertilizers from cow urine and dung.

After two years implementating this project, the outcome of this project were as follows:

1) Farmer groups have new knowledge and skills in dealing with artificial insemination and cattle management, although in daily practices, the researchers or representative from office of animal husbandry still provide assistance to the farmers;
2) Farmers have skills in making fodder from palm midrib (before, it was considered as waste) as well as managing fodder stock for one year;
3) Farmers have skills in making organic fertilizers from cow urine and dung.

The impacts of this project (after 4 years implementation) were as follows:

1) Population of cows and buffalos increased almost double, and health quality of cattle improved;
2) Having cattle feed stock for one year;
3) Having organic fertilizer for their palm plantation (saving 40%-50% of chemical fertilizer);
4) Increased farmer's income and welfare;
5) Having better and clean environment.

Policy implication of this project among others are (1) the local government office launched a new policy on cattle treatment by using artificial insemination. Each subdistricts were equipped with an artificial insemination officer from animal husbandry office to help the farmers; (2) local government was more concerned on health quality and productivity of cattles, thus a cattle breeder center was built in each districts. Appendix IV provides summary of the OIBE results of the case study 2.

Case 3. Introduction of appropriate technologies for economic empowerment in the coastal community

Two researchers (Masters degree) and two undergraduates as technical assistants from Appropriate Technology Division of PRI 'A', implemented various improved appropriate technologies in the community empowerment project. The program was held within 2010 to 2014 in Selat Nasik subdistric, Belitung District, Bangka Belitung Island. Types of appropriate technologies produced and introduced to the community and SMEs among others were equipments/machines for making fish crackers, squid crackers, and other added value local products. In implementing the appropriate technologies, this institution cooperates with local government and local SMEs.

The projet also held some training for entrepreuners in small and medium enterprises (SMEs), particularly related to the management and commecialization of their local products, such as crackers, pepper, honey, salt fish, and many other local products. Most of the business doers are women. About 41 SMEs, 25 households with total of 150 persons involved in the training held by this project within 2010–2014.

After users adopted new appropriate technologies from PRI 'A', we found out that users, particularly SMEs have the ability to replicate the technologies. This was considered as one of the impact of the project. Their production (such as

various crackers and other local products) even increased, and they can create larger market. For example, at the beginning, only 5 SMEs produced fish crackers with the average production of 500 kg per month. After 4 years using new technology from PRI 'A', there were 17 SMEs which produced fish crakers and their production increased to 2,000 kg per month. The project did not only introduced better technology, but also increased SMEs capabilities. They also assisted SMEs and community in packaging and business management, including making their own brand and registering to get the sertificates from Agency for Drug and Food Processing (BPOM) and Ministry of Health.

Although this project has benefited many SMEs and community in Belitung island, the local government has not issued yet any new regulations or policies to support the project. The only support is facilitating marketing of the products by building the souvenir shop in the center of Belitung town. Appendix V provides summary of the OIBE results of the case study 3.

B. Barriers factors in achieving outcomes and impacts

Results of the study reveals that there are several factors identified as barriers or they do not support the achievement of outcomes and impacts of this program. First is related to research management and policy, including proper assessment of research proposal, research design, research activities, monitoring and evaluation. For example, many of those documents did not mention outcomes and users very clearly, hence added value of the products (research results) are not achieved. There were also no prerequisite in resulting the outputs and outcomes. The best value of research results to get impacts are that technology (prototypes) that introduced to the firms have reached certain technology readiness level. By not having those requirements, as a consequence, evaluators can not 'blame' the researchers for not having outcomes of the project. One requirement for having impacts is that research results should have added value and market demand. Other weaknesses are that assessments of research facilities and research group capability are not included in the proposal and research designs assessment. Those are examples of 'untight' proposal assessment.

Second, research policy is different among sub-coordinators. One coordinator focuses on scientific writings as an output and others are focused on outcomes. National policy on using or spending research budget is 'hard' to adjust and additional funding is hard to find in the middle of the research work. Finishing research project (due to less funding) in the middle year is considered as a failure. This failure affected all researchers' performance involved in this particular CRP. Although CRP adopted a principle of multi-years, multi-institutions, and multi-competences, in reality, there is a lack of assessment pertaining to those aspects. There is also a lack of monitoring and evaluation of the research substance, particularly in making a cross check with the field research. This is due to the lack of budget for monitoring and evaluation. The different missions between PRI 'A' and industry are often considered as a failure factor in developing research cooperation and commercialization at PRI 'A'. PRI 'A' needs more communication with firms. PRI 'A' also still has to build verificator team for determining innovation readyness level and demand readiness level assesments.

Grand design of this CRP should be developed towards outcomes and impacts. Although CRP is a top-down approach research program, to get significat impacts, there should have been a synergy among individual research groups under one sub-coordinator. Finally, a clear and operational policy for research commercialization should be developed by PRI 'A'.

V. CONCLUSION AND IMPLICATIONS

In Indonesia, research activities are mostly conducted at PRIs with the majority of funding comes from government. OIBE at PRIs will inform policy makers at government and other stakeholders levels about their research results, particularly in terms of outputs, outcomes and impacts to improve human quality, environmental conditions, influence policy and upgrade existing technology and innovation in industry.

Outputs resulted from 188 projects under CRP are mostly in the form of 728 scientific publications, 27 registered patents, 108 prototypes of technology, 50 development models and 36 policy recommendations for central and local governments. As far as outcomes and impacts of this research results are concerned, it is still considered very small. It was found out that only three projects were still in operation until 2017, and being considered as sustainable projects.

Our research provides evidence that the impacts of the three projects are determied by four aspects, namely: (1) economic point of view such as increased users income, fulfilled market demand, jobs creation in the community, and provisionof alternative raw materials for industry; (2) new technology/new knowledge for liquid organic fertilizer and modification of appropriate technology as well as improved industrial process and creation new knowledge; (3) social and evironmental impacts are shown by improvement of environment or lessening pollution, creation of security in the community, particularly after the adoption of the new technology and increased collaborations among users; and (4) change organization and management in the users and partners side. For examples, new cooperatives are developed for liquid organic fertilizer in several villages of Wonogiri and Gresik Districs, as well as creating new partners both from users and PRI points of view.

Our study tried to enrich the literature related to OIBE research activities in PRI by using an in-depth OIBE working analysis. However, the case studies demonstrated that several barriers exist in achieving outcomes and impacts, such as those related to research management and policy, including proper assessment of research proposals, research design, research activities, monitoring and evaluation. There are no requirements for the researchers to achieved added value products or be at certain level of technological readiness to implement in firm or industry. Other weaknesses are that assessments of research facilities and research group capability are not included in the proposals and research designs assessment. It seems an 'untight' proposal assessment was conducted for CRP.

Research policy is different among subcoordinators, while monitoring and evaluation of the research substance are very lacking, particularly in the cross-checking with the field research. Therefore, researh cooperation and commercialization of the research products are very small. The grand design of this CRP should be developed towards outcomes and impacts as well as making priority in developing a clear and operational policy for research commercialization.

Implications for having outcomes and impacts of the research results are that PRI 'A' should improve their research policy and management. PRI through their researhers should establish collaboration with firms/industries. Industries frequently have no connections to researchers at PRI and may not know how to initiate a co-production project. Therefore, PRI 'A' should become more proactive in identifying industries with potential for co-production. This also implies that more human resources mobility is required. Clear guidelines, targets of outcomes and impacts for their research results should be emphasized from the beginning of the project.

ACKNOWLEDGEMENT

We are grateful to PAPPIPTEK-LIPI for providing the research funding under fiscal year 2017.

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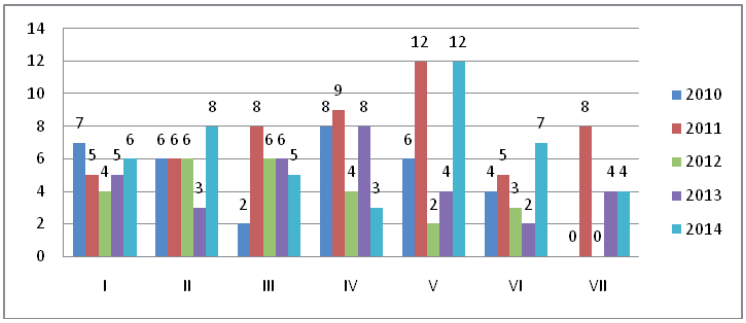
APPENDIX I.

The scope of the study is 188 CRP projects (conducted by more than 25 R&D centers under PRI 'A') that was completed within 2010 until 2014 as shown below.



Source: Prepared from CRP Report 2010-2014

Figure A1. Total CRP per sub program, 2010-2014

Note : I – VII name of CRP's sub program

I. Eksploration and the use of measurable biological resources (land and marine) Indonesia;
II. Molecular Farming and Herbal medicines raw materials;
III. Advanced Materials and Nano Technology;
IV. Renewable Energy and Sustainable Clean Water Supply;
V. Regional Resilience, Competitiveness, and Coastal Communities;
VI. Environment and Natural Disaster;
VII. Critical Strategic Social Issues.

APPENDIX II. FOCUS OF THE STUDY

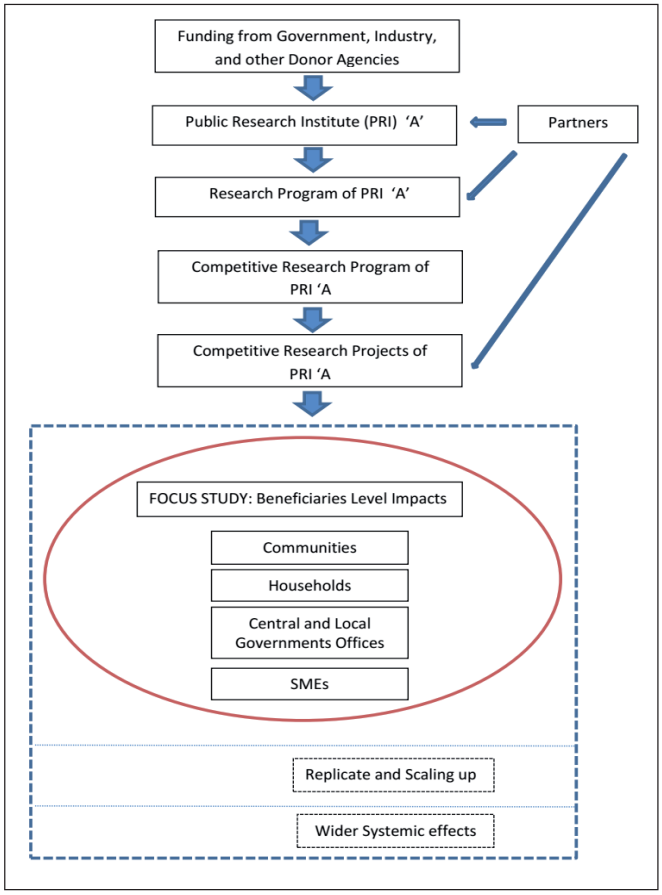


Figure A.2 Focus of the study

APPENDIX III

Summary of the OIBE results of the case study 1 : Selected land microbes project for sustainable agriculture and environment

INPUTS →	PROJECT ACTIVITIES →	OUTPUTS →	OUTCOMES --- IMPACTS		
			Immediate	Short-term	Long-term
Year start 2008	2008-2010	2008-2010	2011-2012	2013-2015	2016 - 2017
Scientific knowledge capacity of the researchers in this project; Skills capacity of the technicians in this project; Skills, knowledge and others supports from the partners; Government funding; R&D facilites at the R&D center and industry; Other supports from management.	Basic research; Applied/development research; Training; Advocation; Coordination/collaboration; Dissemination; Evaluation; Project Management.	Prototype of liquid and granule organic fertilizer; Prototype of production facilities of liquid organic fertilizer; Better trained farmers; Research network and collaboration; Scientific publications and manual for producing organic fertilizer; Patent of liquid organic fertilizer; Policy brief for regional and central government.	Research Institute gained: Increased researchers and technician capacity; Improved scientific knowledge; Expansion of the network; Increased trust from the users.	Research environment improved; The trust from outside parties, such as donors, industries and local governments increased; Continuation of the research.	Research conditions, management, and funding improved; Provision of good quality of researchers and technicians; Continuation of the research.
			Communities/House-holds/ SMEs and industry/other stakeholders gained: Farmers and others practitioners' have capabilities in making liquid organic fertilizer;.	Increased productivity about 50%; Increased income about 50%; Job/employment creation.	Better economic and social prosperity; Better environment; A cooperative has been built.
			Government gained: Improved regulations on using fertilizers; Creation of new program.	Improved regulations on using fertilizers; Creation of new program.	Improved regulations on using fertilizers, environment; Creation of new program.

APPENDIX IV

Summary of the OIBE results of the case study 2: Community empowerment at the village level through biotechnology (cattle breeding)

INPUTS →	PROJECT ACTIVITIES →	OUTPUTS →	OUTCOMES --- IMPACTS		
			Immediate	Short-term	Long-term
Year start 2009	2009-2011	2009-2011	2012 - 2013	2014-2015	2016 - 2017
Scientific knowledge capacity of the researchers in this project; Skills capacity of the technicians in this project; Skill, knowledge, and others supports from the partners; Government funding; R&D facilites at the R&D center and industry; Other supports from management.	Basic research; Applied/development research; Training; Advocation; Coordination/collaboration; Dissemination; Evaluation; Project Management.	Prototype of artificial insemination; Prototype of cattle feed proccessing technology from palm midrib; New formula of organic fertilizers from cow urine and dung; Better trained farmers; Research network and collaboration; Scientific publications and manual for producing organic fertilizer; Policy brief for regional government;	Research Institute gained: Increase researchers and technician capacity; Improved scientific knowledge; Increased network; Increased trust from users.	Research environment improved; The trust from outside parties, such as donors, industries and local governments increased; Continuation of the research.	Improvement in research conditions, management, and funding; Provision of good quality of researchers and technicians; Continuation of the research.
			Communities/Households/ SMEs and industry/other stakeholders gained: Farmer groups have new knowledge and skill in artificial insemination and cattle management; Farmers have skills in making fodder from palm midrib, managing fodder stock for one year, and in making organic fertilizers from cow urine and dung.	Increased population of the cattle and improved health and quality of the cattle; Producing organic fertilizer for their palm plantation (saving 40%-50% of chemical fertilizer). Increased farmer's income and welfare; Better and clean environment; Job creation.	Better economic and social prosperity; Better environment.
			Government gained: Improved regulations on husbandry and creating new program.	Regulations on husbandry improved and creation of new program.	Regulations on husbandry improved and creation of new program.

APPENDIX V

Summary of the OIBE results of the case study 3: Introduction of appropriate technologies for economic empowerment in the coastal community

INPUTS →	PROJECT ACTIVITIES →	OUTPUTS →	OUTCOMES --- IMPACTS		
			Immediate	Short-term	Long-term
Year start 2010	2010-2014	2010-2014	2015 - 2016	2017	2018 (as expected)
Scientific knowledge capacity of the researchers in this project; Skills capacity of the technicians in this project; Skills, knowledge and others supports from the partners; Government funding; R&D Facilites at the R&D Center and industry; Other supports from management.	Development research; Training; Advocation; Coordination/collaboration; Dissemination; Evaluation; Project Management;	Prototype of various food processing technologies; New recipes of various foods; Better trained SMEs and community; Network and collaboration with SMEs and regional government; Academic and non academic papers;	<u>Research Institute gained:</u> Increased researchers and technician skills; Improved existing grassroots technology; Increased network; Increased trust from the users.	Research environment improved; The trust from outside parties, such as industries and local governments increased.	Improvement in research conditions, management, and funding. Provision of good quality of researchers and technicians; Continuation of the research.
			<u>Communities/House-holds/ SMEs and industry/other stakeholders gained:</u> Number of SMEs increased Incresed ability of SMEs in innovating the food processing technologies; Increased production, as well as food innovation ; Create larger market and built big souvenir shop.	Increased communities' income and welfare; Better and clean environment; Job creation.	Sustainability of the entrepreneurship; Better economic and social prosperity for the community ; Better environment.