Assessing the Economic Potential of Public-Private Partnerships (PPPs): An Ex-ante Cost-Benefit Analysis for Agricultural R&D in Southern Philippines

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Abstract

With the growing emphasis on reducing costs within the government, it is increasingly important for public research institutions to adopt more cost effective approaches for the provision of public services, while at the same time aiming to enhance the use of innovations and research outputs to reduce poverty and improve the livelihoods of more people. Public-private partnerships in agricultural R&D have been recognized as an effective method to address these issues. This paper has examined the cost and benefits of public-private partnerships (PPPs) in agricultural research and development. With the assumptions on the benefits of PPP based on literatures and case studies reviewed, the results of the cost-benefits analysis suggest positively higher returns to the investment in collaborative research (With PPP) when compared with non-collaborative research (Without PPP). The technology adoption scenarios have also shown that the estimates of the increase of adoption rates and the earlier adoption expectation are highly relevant and significant for getting a higher return on the investment. The analysis concludes that the inclusion of the private sector in public research and development initiatives in agricultural R&D can generate higher welfare benefits that have the potential to provide positive net benefits and bigger impact for the agencies working in the research partnerships.

Keywords: “With and without PPP”, Impact assessment, Australian Centre for International Agricultural Research (ACIAR)

Introduction

Public-partnerships in agricultural R&D has become recognized as an efficient method for doing advanced, developing new technologies, and deploying new products for the benefit of resource-poor farmers particularly in the developing countries (Ion, et al., 2014). Public and Private actors try to use this partnership strategy to help address the weakening of government intervention in agriculture in many developing countries (Cargani & Kherallah, 2014). Empirical evidence has shown that the growth rate of public expenditure on agricultural sector has dropped significantly in most developing countries, causing some supported centers to decline in real terms and become increasingly restricted in their contributions (World Bank, 2003). Baxter (2013) reports that investment in aid-related areas such as research and development...
(R&D) appears to be decreasing over time and notes that there could be a corresponding opportunity for potential investment in these areas by the private sector. He also emphasized that there is an increasing involvement of business and private sectors, not just in research and development, but also in infrastructure development, service delivery, public health, community and rural development. However, despite this increasing investment and potential to enhance developments, in the area of agriculture, in particular, it has also been reported that investment in R&D has rarely benefited the poor and small-scale farmers. Some literatures report failure rates for some public-private alliances, ranging from 30 to 70 percent (Barringer and Harrison, 2000; Park and Ungson, 2001; Zaman and Mavondo, 2009 as cited in Baxter, 2013). Therefore, it is worth exploring to examine specific case studies of public-private partnerships (PPP) focused on investment and development in the agricultural sector to provide a better understanding of the factors which determine success or failure of such partnership and investment.

Public-Private Partnerships (PPP) have been accepted for providing more efficient public services in the infrastructure, health, and education sectors, while they are also becoming strongly promoted as a new approach for carrying out and development (R&D) in the agricultural sector, especially in developing countries. However, despite this resurgence in the importance of partnerships, there have been few studies done to quantitatively examine and analyze the benefits and costs of public-private partnerships, especially in the areas of agricultural. The question on whether the benefits associated with the collaborative roles outweigh the costs is vital for establishing a sound basis for decision-making frameworks for public-private sector engagement in partnerships for agricultural R&D. The question of whether these public-private partnerships could help in the enhancement of the adoption of outputs also has relevance in relation about the preparation of PPP contracts and partner selection procedures. This study tries to fill this knowledge gap and provide insights into these issues, addressing the economic and financial viability of public-private partnerships for the different stakeholders, including limited resource farmers.

**Review of Literatures**

The term PPP has been described broadly in various literatures and has gained interest around the world. Public-private partnerships can be viewed in many ways: a) as a cooperative institutional arrangement which could be used as a new governance tool that will replace traditional methods; b) as a new expression in the language of public management; and 3) as a new way to handle infrastructure projects (Hodge & Greve, 2007). Public-Private Partnerships in agricultural sector and innovation are a “collaborative mechanism in which actors in fields and in the private sector share resources and risks, and generate innovations for the development of the agricultural sector, including livestock, forestry and fisheries sectors” (Hartwich, et al., 2007). These two entities, public and private, share their resources, knowledge and risks, aiming to achieve more efficient production and delivery systems for their products and services. Possible partners usually include, research institutes, universities, and extension agencies in the public sector, and also the producers’ associations, businesses, and individual producers in the private sector. In addition, the findings of (Spielman, et al., 2007) in the CGIAR study for their 75 projects suggest that centers leverage PPPs to pursue several types of cost-reduction strategies, including the outsourcing activities, securing alternative financing, and making the prohibitive possible. The study also suggests that small domestic firms in developing countries leverage PPPs to have a competitive advantage over their
competitors, or to carve out their own niche, in emerging markets. This is particularly the case with local seed firms when PPP’s provide access to research centers’ improved breeding materials, which can expand a firm’s product lines and the opportunities to realize profits over relatively short time horizons (Spielman, et al., 2007).

Research Framework

Comparative evaluation of the PPP experience based on related research institutions can provide evidence that will help us understand the actual roles and positive benefits of public-private sector engagement and collaboration of doing advanced research in agricultural sector, development, and extension. This research has reviewed some case studies that have adopted PPP in their research projects and assessed whether these could also be viable for other public institutions. Using evidences from reviewed case studies, this paper assessed the economic potential of PPPs in agricultural research and development using the comparative cost-benefit analysis (see Figure 1). This type of analysis is ex-ante in nature, meaning the PPP’s economic potential are assessed prior the official establishment of the partnerships strategy. Hence, this is an ex-ante impact assessment for PPPs strategy applied for ACIAR’s R&D projects. But this is considering the changes in organizational structure in terms of ACIAR’s internal resource allocation and operations incorporating PPP as a new approach. The most intriguing question to answer in this paper is whether it is more cost effective for ACIAR (or any other research for Development Agency) to adopt a new model for their R&D operations rather than continuing with the traditional one, and whether the PPP model can help ACIAR enhance the adoption of their research outputs. Furthermore, this analysis could provide information for synergy conditions where the benefits of the collaboration are higher than the benefits without the collaboration.

Objectives

The objectives of this research were to deliver the following:

- An understanding of when and how PPPs bring about positive development outcomes and impacts in agriculture;
- An empirical examination of evidence of PPPs impacts on organizations;
- An investigation of the financial viability of PPPs in the conduct and implementation of public projects through the conduct of benefit-cost analysis (BCA).
Methodology

Cost-Benefit Analysis

Cost and benefit analysis (CBA) is a technique for the identification, measurement and comparison of benefits and costs of an investment project, to guide for decision makers in choosing the most beneficial projects for implementation from the alternatives available (Campbell & Brown, 2003). In this report, the CBA is undertaken to determine the differences between conducting a project through the use of a conventional mode, as compared with implementation using a PPP. The objective of the analysis is to compare the same project “with” and “without PPP” throughout the entire chain of the pathways available to deliver change, from the financing of inputs and sharing of resources, through to the dissemination and utilization of outputs and adoption of technologies. The aim of the cost-benefit analysis in this paper is to understand whether the inclusion of the private sector in the public’s and development initiative in agriculture R&D&E would have potential positive net benefits and bigger impacts for the agents acting in the partnerships. This study is designed based on a comparison of the conventional approach and the PPP approach (Figure 2). The assumptions and data collected are outlined, followed by the financial analysis, and then socio-economic and sensitivity analysis. Finally, the results of the analysis are reviewed, and the primary question, ‘which approach generates higher welfare’, is discussed.

Figure 2. Benefit-Cost Analysis (Ex-Ante) framework
Data Sources

The study and related analysis presented in this paper are based on secondary data which were gathered from case studies, institution websites, and previous studies on PPPs. Australian Centre for International Agricultural Research (ACIAR) is used in this study as an example of a public institution. ACIAR R&D programs are responsible for developing, monitoring and evaluating projects. The programs are broadly clustered within the areas of economics and systems; crops, natural resources management; and livestock and fisheries. In this study, the focus is on the economic assessment of components of horticulture projects which ACIAR has undertaken in the Philippines last 2013.

Results and Discussion

ACIAR-PPP Technology Adoption Scenarios

A parameter that is critical to the benefits of technological change is the pattern of adoption by farmers (Norton & Hautea, 2009). Adoption often follows an S-shaped pattern approaching its maximum level asymptotically (Alston, et al., 1995). In this study, three distinct adoption rate patterns have been analyzed (Figure 3). The base case scenario (A1) “Without Research” implies there is adoption of technology even without research through farmer’s own experimentation and skills. The other scenario (A2) “With ACIAR Research” represents the adoption of technology attributed through ACIAR research, in this example, ACIAR’s research and activities; and (A3) “With ACIAR/PPP Collaborative Research” assumes the rate and uptake of technology adoption when ACIAR and the private sector collaborate in a research undertaking. Theoretically, it can be expected that there is earlier adoption and a higher adoption rate of technologies attributed through research. It is also assumed that with the partnerships strategy, the potential adoption rate of technologies could be enhanced.

ACIAR projects covered in this study:

ACIAR is used in this study as an example of a public institution. ACIAR R&D programs are responsible for developing, monitoring and evaluating projects. The programs are broadly clustered within the areas of economics and farming systems; crops, natural resources management; and livestock and fisheries. In this study, the focus is on the economic assessment of components of horticulture projects which ACIAR has undertaken in the Philippines. These projects are: Integrated Pest Management (IPM) for Mango and the Integrated Management of Phytophthora disease for Jackfruit in the southern Philippines. The data presented in this report are primarily taken from ACIAR Proceeding 139, Smallholder HOPES - horticulture, people and soil (ACIAR, 2013).

Shared R&D Costs

Table 2 below are the assumptions used for calculations of partner contributions that can serve as a basis for negotiation for the public-private partnership for the ACIAR projects. These calculations are based on the Hartwich et al. (2007) manual for building public-private partnerships for agricultural innovation.

Adoption rates (with and without PPP) estimates

Table 3 and 4 below shows the comparison between the technology adoption scenarios for the “Without PPP”, “With PPP”, and “Without Research”. In this paper, an earlier adoption of technologies is expected when recommendations are based on the research. That is, without the ACIAR projects it would have been a considerably longer period before
the technologies would be adopted in the farms. The research project brings the adoption forward.

Table 3 shows the estimated adoption rates for jackfruit’s phytophthora control strategies. It is estimated that for “Without” ACIAR research scenario, improvement of management practices for jackfruit would start at year 2020. However, with the research, both “Without PP” (ACIAR only) and with “With PPP” (ACIAR with Private partners) the adoption starts earlier, in 2016 and 2014, respectively. It is also assumed that after allowing 4 years to building up knowledge and training, this adoption will reach a maximum of 50% after 8 years (in 2024) as a result of the research project.
of research and extension conducted solely by ACIAR. Table 4 shows that estimated adoption rate for Mango’s Integrated Pest Management (IPM) recommendations. It is expected that through research partnerships between ACIAR and the private sector, there would be an earlier start of adoption (in 2012) and this adoption would reach a maximum of 65% after four years (in 2016). Comparatively, the “without and with PPP scenarios” started adoption in the same year, but the collaborative research is expected to result in higher rates of uptake and would reach the potential maximum adoption rate earlier than would be the case without the collaboration.

**Estimating the benefits associated with adoption**

The projects generate benefits when the introduced technology recommendations for jackfruit and mango are adopted and applied by farmers on their farms. The suggested improved practices for these commodities would deliver a range of types of benefits, including reduced crop damage or reduced yield losses, reduced costs of production, and improved yield. The first two steps involved in calculating the benefits are: a) determining the size of the industry; and b) estimating the area affected by the pest and/or disease problem covered by the study. The last step involved determining the likely level of adoption within the affected region (Preciados, et al., 2013).

A researcher interview was done to determine the extent of the problem that was being addressed, and what the potential impacts of the will be, and in the researchers’ opinion, what was the likely level of adoption within the affected region.

**Determining the scope and extent of the problem**

Table 5 presents the baseline information about the size of the industry and the extent of the problem that each of the ACIAR projects is trying to address. From the researcher interviews conducted in the ACIAR study, it was estimated that 57.5% (332.5 ha) of the total jackfruit production area in Region VIII (Eastern Visayas) is affected by the phytophthora disease problem (Preciados, et al., 2013). Preciados, et al. (2013) also mentioned that in Region XI, 40% of the (7,255 ha total mango production area is affected by the problem of fruit damage caused by the thrips, cecid fly and scab. Table 5 implies the potential area of adoption for the suggested technologies based on the research addressing the identified scope and extent of the problem.

**Farm level Gross Margins Impacts**

Table 6 shows that adopting the recommendations from the ACIAR research will help farmers increase their farm incomes due to the reduced yield loss due to better control of pest and disease problems. The changes in yield and production costs associated with the adoption of the research recommendations would result in increased gross margins for jackfruit and mango leading to higher positive net benefits (Preciados, et al., 2013). However, there are various constraints identified that may have potentially impede the adoption of the technologies and limit the potential benefits for farmers.

**ACIAR-PPP estimates of likely adoption Profile**

A preliminary estimate of the adoption rates has been made by key researchers and extensionists involved in the ACIAR project (Preciados et al., 2013). In the previous study, scientist estimated the minimum, most likely, and maximum potential of adoption of the research recommendations. In this report, we have used the conservative minimum estimates so as not to overstate impacts. Based on the information relating to adoption rates and adoption expectations, the estimate of adoption impacts of the “With
Table 3. Jackfruit Phytophthora Research Adoption Rates Assumptions.

<table>
<thead>
<tr>
<th>Jackfruit Phytophthora Unit</th>
<th>Year start of the adoption</th>
<th>Initial rate of adoption</th>
<th>Time to reach maximum adoption</th>
<th>Maximum rate of adoption</th>
<th>Adoption after 15 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1 (without research)</td>
<td>2020</td>
<td>2</td>
<td>10</td>
<td>35</td>
<td>35</td>
</tr>
<tr>
<td>A2 (with ACIAR)</td>
<td>2016</td>
<td>5</td>
<td>8</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>A3 (with ACIAR+PPP)</td>
<td>2014</td>
<td>7</td>
<td>6</td>
<td>65</td>
<td>65</td>
</tr>
</tbody>
</table>

Source: Author’s estimates based on previous studies and scientist interviews (Preciados, et al 2013)

Table 4. Mango IPM Research Adoption Rates Assumptions.

<table>
<thead>
<tr>
<th>Mango IPM Unit</th>
<th>Year start of the adoption</th>
<th>Initial rate of adoption</th>
<th>Time to reach maximum adoption</th>
<th>Maximum rate of adoption</th>
<th>Adoption after 15 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1 (without research)</td>
<td>2015</td>
<td>3</td>
<td>7</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>A2 (with ACIAR)</td>
<td>2012</td>
<td>5</td>
<td>5</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>A3 (with ACIAR+PPP)</td>
<td>2012</td>
<td>8</td>
<td>4</td>
<td>65</td>
<td>65</td>
</tr>
</tbody>
</table>

Source: Author’s estimates based on previous studies and scientist interviews (Preciados, et al 2013)

Table 5. Projects Scope of Research

<table>
<thead>
<tr>
<th>Region in Philippines</th>
<th>Size/area of the industry</th>
<th>% industry affected (production study)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Jackfruit Phytophthora</td>
<td>Eastern Visayas Province (Region VIII)</td>
<td>578 ha</td>
</tr>
<tr>
<td>2. Mango IPM</td>
<td>Davao Province (Region XI)</td>
<td>18,137 ha</td>
</tr>
</tbody>
</table>

Source: Author’s estimates based on previous studies and scientist interviews (Preciados, et al 2013)

Table 6. Gross margins and farm-level net benefits of the technologies.

<table>
<thead>
<tr>
<th>Research</th>
<th>Unit</th>
<th>Gross Margins (current farmers’ practice)</th>
<th>Gross Margins (with technology)</th>
<th>Net Benefit Adoption (pesos/unit)</th>
<th>Net Benefit Adoption (pesos per hectare)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Jackfruit Phytophthora</td>
<td>Pesos/tree</td>
<td>1,587</td>
<td>2,749</td>
<td>1,162</td>
<td>200,529</td>
</tr>
<tr>
<td>2. Mango IPM</td>
<td>Pesos/tree</td>
<td>329</td>
<td>842</td>
<td>513</td>
<td>51,250</td>
</tr>
</tbody>
</table>

Source: Author’s estimates based on previous studies and scientist interviews (Preciados, et al 2013)

PPP" research scenario can be used in the calculation of net benefits of adoption.

Evidence is shown in the researcher interviews conducted in the ACIAR study (Preciados, et al., 2013), relating farmers adopting suggested best practices from ACIAR recommendations (Table 7). In general, farmers will adopt the technology only if it promises to increase farm output and that potential rewards will more than offset the costs and risks involved.

Financial Analysis

To account for the time preference for the use of money (opportunity costs), future benefits and costs were discounted to present values (Rand, 2005). All costs and benefits expressed in constant dollar terms were converted to Philippine peso and discounted to the current financial year. Investment benefits were measured using the investment criteria of Net Present Value (NPV) and Benefit-Cost Ratio (B/C Ratio). The NPV is the difference between the PV of benefits and the PV of
Table 7. ACIAR projects constraints on adoption and PPP potential contribution.

<table>
<thead>
<tr>
<th>Technology</th>
<th>Constraints/expectations on adoption</th>
<th>PPP potential role</th>
</tr>
</thead>
</table>
| Jackfruit Phytophthora (Preciados, et al., 2013) | 1. Availability of chemicals
2. Availability of funds to implement recommendations
3. Dissemination of research recommendations | XXX
XX
XX |
| Mango IPM (Preciados, et al., 2013) | 1. Most farmers (80%) are in contract-growing schemes. The farmers do not decide on the spraying activity or the pest management of their mango orchards. A calendar-based spraying program is implemented by contractors (Preciados, et al., 2013).
2. Significant time may be needed to build-up knowledge of the new practices (Preciados, et al., 2013). | XXX
XX |

X = minimum potential; XX = medium potential; XXX = large potential

Source: Scientist interviews conducted by the author in a previous ACIAR study (Preciados, et al., 2013). The PPP potential roles are the current expectations of the author.

RD&E costs, while the B/C ratio is the PV of benefits divided by the PV of the research costs (Rand, 2005). The NPV is calculated on an annualized basis over 20 years. The 5% discount rate is used, as this is the rate that has been used in ACIAR assessments. Sensitivity testing was undertaken at 0%, and 10%, as per ACIAR guidelines for assessing the impacts of their research activities (Davis et al., 2008).

ACIAR Research case studies

Case study 1: Jackfruit Phytophthora Research

Benefits and Costs Ratio

At a 5% discount rate, the expected net present value of Jackfruit Phytophthora research (Without PPP) in Region VIII (Eastern Visayas, Philippines) is 107.32 million pesos, with a benefit:cost ratio of 23:1, which means that for every peso invested in the research (by ACIAR only) to control Phytophthora in jackfruit, a benefit of 23 pesos can be expected. This represents an internal rate of return of approximately 30% (Preciados, et al., 2013). Comparatively, at 5% discount rates, if the research had been conducted by ACIAR with private sector involvement (i.e. with PPP) scenario, when costs are shared and adoptions are enhanced, the research would bring higher benefits to ACIAR, with higher net present value and a benefit:cost ratio of 235.7 million pesos and 99:1, respectively (Table 8).

Jackfruit ACIAR-PPP Research adoption expectations

Figure 3 below shows the comparison between the technology adoption scenarios for the “Without PPP”, “With PPP”, and “Without Research”. In this report, an earlier adoption of technologies is expected when recommendations are based on the research. That is, without the ACIAR projects it would have been a considerably longer period before the technologies would be adopted in the farms. The research project brings the adoption forward.

As exemplified in Figure 3, relying only on farmers own experimentation (Without Research) the initial year of the start of adoption is 2020. However, with the research, both ‘Without PPP’ (ACIAR only) and with ‘With PPP’ (ACIAR with Private partners) the adoption starts earlier, in 2016 and 2014, respectively. The recommended technology involves the application of AgriFos trunk
Table 8. Jackfruit Phytophthora BCR.

<table>
<thead>
<tr>
<th>Standard Measures</th>
<th>Research (<em>Without PPP</em>)</th>
<th>Research (<strong>With PPP</strong>)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NPV</td>
<td>107,323,224</td>
<td>235,698,850</td>
</tr>
<tr>
<td>BCR</td>
<td>23</td>
<td>99</td>
</tr>
<tr>
<td>IRR</td>
<td>30%</td>
<td>61%</td>
</tr>
</tbody>
</table>

*Without PPP - without the private sector scenario which means the R&D&E undertaken is through ACIAR only and does not combine inputs, skills, and resources from the private sector.

**With PPP - with a collaborative R&D&E scenario between ACIAR and the private sector partners.

Figure 4. Jackfruit Phytophthora PPP Research Adoption Profile.

injection and it is expected that adoption will occur from 2016 with the ACIAR research (Without PPP). It is also assumed that after allowing 4 years to building up knowledge and training, this adoption will reach a maximum of 50% after 8 years (in 2024) as a result of research and extension conducted solely by ACIAR. The expectation on adoption with research conducted in partnership between ACIAR and the private sectors is that the adoption rate would be enhanced. As the AgriFos required for injection into the trunk of Jackfruit trees is not available on the domestic market in the Philippines, the application of the technology might need the cooperation of the international company Agrichem to import the chemical to the Philippines. With the collaboration of ACIAR, private companies and the government, the registration and licensing of products such as AgriFos will be quicker. This would help address that constraint on the adoption by jackfruit growers who are interested in the technology, leading to higher adoption rates. Hence, estimates for the adoption of the collaborative research (With PPP) are higher when compared to “Without PPP” and Farmers Practice (“Without Research”). It is expected that the collaborative research would start the adoption process earlier (in 2014) and that the adoption would reach a peak of 65% after six years (in 2020) as a result of the research and extension activities conducted jointly by ACIAR and the private partners involved.
Case Study 2: Mango IPM Research

Benefits and Costs Ratio

At a 5% discount rate the expected net present value of Mango IPM research (Without PPP) in Region XI is 677.72 million pesos with a benefit:cost ratio of 33:1 showing that for every peso put in in the research for mango integrated pest management, we can expect a benefit of 33 pesos, representing an internal rate of return approximately 40%. Comparatively, at a 5% discount rate, if the research had been conducted by ACIAR with the involvement of the private sector ("With PPP") where costs are shared and adoption is enhanced, the research would bring higher benefits to ACIAR, with higher net present value and benefit:cost ratios of 963.7 million pesos and 90:1, respectively (Table 9).

Mango ACIAR-PPP Research adoption expectations

Figure 5 shows that relying only on the farmers own experimentation (Without Research), the initial year of the start of adoption is 2015, but with the research both without PPP (ACIAR only) and with PPP (ACIAR with Private partners) the adoption starts earlier in the year 2012. For mango growers in Region XI, (on Samal Island) in particular, most farmers (80%) are in contract-growing and they do not personally decide on the spraying activity or the pest management of their mango orchards (Preciados, et al., 2013). Instead, they follow a calendar-based spraying program provided to them by a private company. The suggested mango IPM research would create some changes to this practice, as the application of the pesticides is minimal or they are applied only when needed. So if collaboration could have been established between ACIAR and this private company for a partnership in mango IPM research, then farmers would not be reluctant to adopt the suggested chemical application practices which would then translate into an increasing uptake of the technologies in their respective farms. It is expected that through research partnerships between ACIAR and the private sector, there would be an earlier start of adoption (in 2012) and this adoption would reach a maximum of 65% after four years (in 2016) (Preciados, et al., 2013). Comparatively, the “without and with PPP scenarios” started adoption in the same year, but the collaborative research would be expected to result in higher rates of uptake and would reach the potential maximum adoption rate earlier than would be the case without the collaboration.

Conclusions

In this paper, the potential impact of PPP has been measured based on past studies and estimates of relevant parameters and data required to measure relative impacts of project profitability and returns on investments. The key results of the comparative benefit-cost analysis “With PPP” and “Without PPP” are the following:

- The expected net present value of benefits from collaborative research for Jackfruit Phytophthora, and Mango IPM Research in the Southern Philippines are 99:1, and 90:1, respectively. These results suggest positive higher returns to the cost invested in the research.

- The technology adoption scenarios have also shown the estimated differences in adoption expectations and rate of uptakes of technologies recommended when the research is to be conducted through the use of a conventional mode, as compared with research implementation using a PPP. It was found that the estimates of the increase of adoption rates and the earlier adoption expectation are highly relevant and significant for getting a higher return on the investment. It is proposed that an enhancing adoption related strategy is necessary to address this matter to increase benefits of research.
Table 9. Mango IPM BCR

<table>
<thead>
<tr>
<th>Standard Measures</th>
<th>Research (Without PPP)</th>
<th>Research (With PPP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NPV</td>
<td>677,722,260</td>
<td>963,695,750</td>
</tr>
<tr>
<td>BCR</td>
<td>33</td>
<td>90</td>
</tr>
<tr>
<td>IRR</td>
<td>40%</td>
<td>58%</td>
</tr>
</tbody>
</table>

Note: This is just a scenario based on the hypothetical changes from the expected impacts of PPP regarding reduced cost and increased adoption. This basically used as a way of highlighting how PPP benefits could be analyzed.

Figure 5. Mango IPM PPP Research Adoption Profile

- The primary question, ‘which approach generates higher welfare’, is measured in a preliminary way through the quantification of benefit-cost ratios. The results show a higher welfare level in the “With PPP” scenario, based on wider benefits gained about the investment costs, with more farmers benefiting of the adoption of technologies.

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