Potential Of Oil Palm Ash As A New Filler in Natural Rubber Compounds

By
Prof. Dr. Hanafi Ismail

2013
En. Ab. Hafiz Bin Ab. Hadi
Pejabat Pengurusan & Kreativiti Penyelidikan
Aras 6, Bangunan Canselor
11800 Minden, USM

2 Januari 2014

Tuan,

Laporan Akhir Projek Penyelidikan ScienceFund: "Potential of Oil Palm Ash As A Filler in Natural Rubber Compounds (305/PBAHAN/6013380) No Projek: 03-01-05-SF0491

Saya dengan hormatnya merujuk kepada perkara di atas.

2. Bersama surat ini saya sertakan Laporan Akhir Projek (HardCopy) bersama bahan-bahan bukti. Saya juga telah mengemukakan Laporan Akhir Projek secara online melalui system eSciencefund.

Sekian, terima kasih.

Yang Benar,

(PROF DR HANAFI ISMAIL, FASc)
### A. Description of the Project

1. **Project number** : 03-01-05-SF0491  
2. **Project Title** : Potential of oil palm ash as a new filler in natural rubber compounds  
3. **Project Leader** : Hanafi Ismail  
4. **Project Team** :  
   (please provide an assessment of how the project team performed and highlight any significant departures from plan in either structure or actual man-days utilised)  
   All the project team members are in School of Materials and Mineral Resources Engineering, Engineering Campus, USM, Nibong Tebal, Penang  
5. **Industrial Partnership** :  
   (Please describe the nature of collaborators with relevant industry)  
   United Oil Palm Industries Sdn Bhd - provide the oil palm ash for research project.  
6. **National/International Collaboration** :  
   (Please identify research organisations and describe the nature of collaboration)  
7. **Project Duration** : 24 (months)  
   **Start date** : October (month) 2011 (year)  
   **End date** : September (month) 2013 (year)  
8. **Total Budget Approved** : RM 183504
B. Objectives of the Project

1. Socio-economic Objectives (SEO)

Which socio-economic objectives are addressed by the project? (Please Identify the Research Priority Area, SEO Category and SEO Group under which the project falls. Refer to the Malaysian R&D Classification System, 4th Edition.)

<table>
<thead>
<tr>
<th>Research Priority Area</th>
<th>SEO Category</th>
<th>Sub Cluster</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Advanced Material</td>
</tr>
</tbody>
</table>

| SEO Group | Applied Sciences and Technologies |

| SEO Area | Applied Sciences and Technologies |

2. Fields of Research (FOR)

Which are the two main FOR Categories, FOR Groups, and FOR Areas of your project? (please refer to the Malaysian R&D Classification System, 4th Edition)

a. Primary field of research

<table>
<thead>
<tr>
<th>FOR Category</th>
<th>Environmental Sciences</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>FOR Group</th>
<th>Applied Sciences and Technologies</th>
</tr>
</thead>
</table>

| FOR Area | Other environment technology/ industry |

b. Secondary Field of research

<table>
<thead>
<tr>
<th>FOR Category</th>
<th>Material Sciences</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>FOR Group</th>
<th>Polymeric Materials</th>
</tr>
</thead>
</table>

| FOR Area | Polymer composites |

C. Objective Achievement

- Original project objectives

(Please state the specific project objectives as described in Section II of the Application Form)

The aim of the study is to investigate the properties of oil palm ash (OPA) filled in natural rubber compounds which will be compounded using a conventional two roll mill followed by compression molded. Specifically, the objectives of the study are:

1. To utilize the OPA as a new filler in natural rubber compounds and study the effect of OPA loading on curing characteristics, tensile properties, thermal properties, swelling behavior, morphology of tensile fracture surface and Fourier transform infrared (FT-IR) of the palm oil ash filled natural rubber compounds.

2. To evaluate the effect of modification of OPA on the properties of natural rubber compounds in term of curing characteristics, tensile properties, thermal properties, swelling behavior, morphology of tensile fracture surface and Fourier transform infrared (FT-IR) of the OPA filled natural rubber compounds.

3. To determine the potential application of OPA filled natural rubber compounds.

- Objective Achieved

(Please state the extent to which the project objectives were achieved)

All original objectives were achieved.

- Objectives not achieved

(Please identify the objectives that were not achieved and give reasons)

N/A
D. Technology Transfer / Commercialisation Approach, if any.

(Please describe the approach planned to transfer/commercialise the results of the project)

E. Assessment of Research Approach

(Please highlight the main steps actually performed and indicate any major departure from the planned approach or any major difficulty encountered)

Research approach was done according to initial proposed project.

F. Assessment of the Project Schedule

(Please make any relevant comment regarding the actual duration of the project and highlight any significant variation from plan)

The project was completed according to the milestone even though the 2nd year allocation was not received on time.

G. Assessment of Project Cost

(Please comment on the appropriateness of the original budget and highlight any major departure from the planned budget)

Although RM 189,504.00 was approved for this project, but the allocation for 2nd year RM 136,985.00 was only received at the end of December 2012 and not according to the original budget allocated. However, the allocation was used accordingly and the balance at the end of this project was RM 62.89. (Statement from Bendahari USM as shown in appendix A)

H. Additional Project Funding Obtained

(In case of involvement of other funding sources, please indicate the source and total funding provided)
I. Benefits of the Project

(please identify the actual benefits arising from the project as defined in Section III of the Application form. For examples of outputs, organisational outcomes and sectoral/national impacts, please refer to Section III of the Guidelines for the Application of R&D Funding under Science Fund)

1. Direct Outputs of the Project

(Please describe as specifically as possible the outputs achieved and provide an assessment of their significance to users)

i. Technical contribution of the project

a. What was the achieved direct output of the project:

For basic oriented research projects?
- Algorithm
- Structure
- Data
- Other, please specify:

For applied research (technology development) projects:
- X Method/technique
- Demonstrator/prototype
- Product/component
- Process
- Software
- Other, please specify:

b. How would you characterise the quality of this output?

- Significant breakthrough
- X Major improvement
- Minor improvement

ii. Contribution of the project to knowledge

a. How has the output of the project been documented?

- X Detail project report
- Products/process specification documents
- Other, please specify:

b. Did the project create an intellectual property stock?

- Patent obtained
- Patent pending
- Patent application will be filed
- Copyright

c. What publications are available?

<table>
<thead>
<tr>
<th></th>
<th>National</th>
<th>International</th>
</tr>
</thead>
<tbody>
<tr>
<td>Article(s) in scientific publications</td>
<td>How many: 0</td>
<td>8</td>
</tr>
<tr>
<td>Paper(s) delivered at conferences/seminars</td>
<td>How many: 5</td>
<td>4</td>
</tr>
<tr>
<td>Book</td>
<td>How many: 0</td>
<td>0</td>
</tr>
<tr>
<td>Other, please specify:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
d. How significant are citations of the results?

- [x] Citations in national publications  How many: 0
- [ ] Citations in international publications  How many: 4
- [ ] Not yet
- [ ] Not known

2. Organisational Outcomes of the Project

(Please describe as specifically as possible the organisational benefits arising from the project and provide an assessment of their significance)

i. Contribution of the project to expertise development

a. How did the project contribute to expertise?

- [x] PhD degrees  How many: 1
- [x] MSc degrees  How many: 1
- [ ] Research staff with new specialty  How many: 0
- [ ] Other, please specify:

b. How significant is this expertise?

- [ ] One of the key areas of priority for Malaysia
- [x] An important area, but not a priority one

ii. Economic contribution of the project?

a. How has the economic contribution of the project materialised?

- [ ] Sales of manufactured product/equipment
- [ ] Royalties from licensing
- [x] Cost savings  How many: 0
- [ ] Time savings
- [ ] Other, please specify:

b. How important is this economic contribution?

- [ ] High economic contribution  How many: RM0
- [ ] Medium economic contribution  How many: RM0
- [x] Low economic contribution  How many: RM0

c. When has this economic contribution materialised?

- [ ] Already materialised
- [ ] Within months of project completion
- [ ] Within three years of project completion
- [x] Expected in three years or more
- [ ] Unknown
iii. Infrastructural contribution of the project
   a. What infrastructure contribution has the project had?
      - New equipment
      - New/improved facility
      - [X] New information networks
      - Other, please specify:
      Value : RM0
      Investment : RM0

   b. How significant is this infrastructure contribution for the organisation?
      - Not significant/does not leverage other projects
      - [X] Moderately significant
      - Very significant/significantly leverages other projects

iv. Contribution of the project to the organisation's reputation
   a. How has the project contributed to increasing the reputation of the organisation
      - [X] Recognition as a Center of Excellence
      - National award
      - International award
      - Demand for advisory services
      - [X] Invitations to give speeches on conferences
      - Visits from other organisations
      - Other, please specify:

   b. How important is the project's contribution to the organisation's reputation?
      - Not significant
      - [X] Moderately significant
      - Very significant

3. National Impacts of the project
   (If known at this point in time, please describe as specifically as possible the potential sectoral/national benefits arising from
   the project and provide an assessment of their significance)

   i. Contribution of the project to organisational linkages
      a. Which kinds of linkages did the project create?
         - [X] Domestic industry linkages
         - International industry linkages
         - [X] Linkages with domestic research institutions, universities
         - Linkages with international research institutions, universities

      b. What is the nature of the linkages?
         - Staff exchanges
         - [X] Inter-organisational project team
         - Research contract with a commercial client
         - Informal consultation
         - Other, please specify:
ii. Social-economic contribution of the project

a. Who are the direct customer/beneficiaries of the project output?

<table>
<thead>
<tr>
<th>Customers/beneficiaries</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Palm Oil Industries</td>
<td>50</td>
</tr>
<tr>
<td>Total</td>
<td>50</td>
</tr>
</tbody>
</table>

b. How has/will the socio-economic contribution of the project materialised?

- [ ] Improvements in health
- [ ] Improvements in safety
- [x] Improvements in the environment
- [ ] Improvements in energy consumption/supply
- [ ] Improvements in international relations
- [ ] Other, please specify:

c. How important is this socio-economic contribution?

- [ ] High social contribution
- [x] Medium social contribution
- [ ] Low social contribution

d. When has/will this social contribution materialised?

- [ ] Already materialised
- [ ] Within three years of project completion
- [x] Expected in three years or more
- [ ] Unknown

Date: ___________________________ Signature: ___________________________
## PROGRESS REPORT

**Report Period:** Jul-Dec 2013  
*(please indicate report period)*

### A. PROJECT DETAILS

<table>
<thead>
<tr>
<th>Project number</th>
<th>: 03-01-05-SF0491</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Title</td>
<td>Potential of oil palm ash as a new filler in natural rubber compounds</td>
</tr>
<tr>
<td>Project Leader</td>
<td>Hanafi Ismail</td>
</tr>
<tr>
<td>Project Duration</td>
<td>24(months)</td>
</tr>
<tr>
<td>Project Start date</td>
<td>October (month) 2011 (year)</td>
</tr>
<tr>
<td>Project End date</td>
<td>Sep (month) 2013 (year)</td>
</tr>
<tr>
<td>Tel</td>
<td>045996113</td>
</tr>
<tr>
<td>Fax</td>
<td>045941011</td>
</tr>
<tr>
<td>Email</td>
<td><a href="mailto:hanafi@eng.usm.my">hanafi@eng.usm.my</a></td>
</tr>
</tbody>
</table>

### B. FINANCIAL PROGRESS

**i. Approved Project Allocation**

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Allocation (RM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (2011)</td>
<td>RM 46,519.00</td>
</tr>
<tr>
<td>2 (2012)</td>
<td>RM 136,985.00</td>
</tr>
<tr>
<td>3 (2013)</td>
<td>RM 0.00</td>
</tr>
</tbody>
</table>

**ii. Total Allocation Received To date**

| Total Allocation Received (RM) | RM 183,504.00 |

**iii. Total Expenditure To date**

| Total Expenditure (RM) | RM 183,442.00 |

**iv. Balance of Allocation To date**

| Balance of Allocation (RM) | RM 62.00 |

**v. Actual Project Expenditure**

(please report total cumulative expenditure up to the past report period)

<table>
<thead>
<tr>
<th>Project Cost Components</th>
<th>Total Approved Budget (RM)</th>
<th>Total Allocation Received (RM)</th>
<th>Total Cumulative Expenditure (RM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>* Temporary and contract personnel (V11000)</td>
<td>73,254.00</td>
<td>73,254.00</td>
<td>43,089.00</td>
</tr>
<tr>
<td>* Travel and transportation (V21000)</td>
<td>18,750.00</td>
<td>18,750.00</td>
<td>12,402.00</td>
</tr>
<tr>
<td>* Rentas (V24000)</td>
<td>4,000.00</td>
<td>4,000.00</td>
<td>0.00</td>
</tr>
<tr>
<td>* Research materials and supplies (V26000)</td>
<td>57,000.00</td>
<td>57,000.00</td>
<td>108,263.00</td>
</tr>
<tr>
<td>* Minor modifications and repairs (V28000)</td>
<td>9,500.00</td>
<td>9,500.00</td>
<td>5,734.00</td>
</tr>
<tr>
<td>* Special services (V29000)</td>
<td>21,000.00</td>
<td>21,000.00</td>
<td>13,954.00</td>
</tr>
<tr>
<td>* Special equipment and accessories (V35000)</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td><strong>Total direct expenses</strong></td>
<td>183,504.00</td>
<td>183,504.00</td>
<td>183,442.00</td>
</tr>
</tbody>
</table>

Is this performance in line with plan?  
[X] Yes  
[ ] No *(Please complete para vi and vii)*

**vi. Reasons for variations from budget**  
(Please provide the reasons)

**vii. Proposed corrective action**  
(Please give details of the proposed action)

---

Progress Report
C. PHYSICAL PROGRESS

i. Milestone Achievement

<table>
<thead>
<tr>
<th>No</th>
<th>Planned Milestone</th>
<th>Planned Completion Date (MM/yyyy)</th>
<th>Achieved <em>(Yes/No)</em></th>
<th>Actual Completion Date (MM/yyyy)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Preliminary Stage: Preparation of oil palm ash (OPA) and compounding of new OPA filled NR compounds</td>
<td>12/2011</td>
<td>Yes</td>
<td>12/2011</td>
</tr>
<tr>
<td>2</td>
<td>Stage 1: Study of cure characteristic, mechanical properties, thermal properties with different load</td>
<td>08/2012</td>
<td>Yes</td>
<td>08/2012</td>
</tr>
<tr>
<td>3</td>
<td>Stage 2: Improving the properties of new OPA filled NR compounds by modifying the OPA particles</td>
<td>02/2013</td>
<td>Yes</td>
<td>02/2013</td>
</tr>
<tr>
<td>4</td>
<td>Stage 3: Data analysis and determination of the potential application OPA filled NR compounds</td>
<td>06/2013</td>
<td>Yes</td>
<td>06/2013</td>
</tr>
<tr>
<td>5</td>
<td>Project Completion</td>
<td>09/2013</td>
<td>Yes</td>
<td>09/2013</td>
</tr>
</tbody>
</table>

ii. Project Achievement

(please provide details on the project achievements, its status and prospects with regards to the followings:)

1. Intellectual Property Rights (Patent, Industrial Design, Trademark, Copyright etc)

2. Publications and papers (International, national, books, citations etc)


3. Expertise Development (PhD, Masters, Research Staff with new specialty etc)

1 MSC student has graduated and 1 Phd in the process of submitting thesis

4. Prototype (prototype name, type eg, lab scale, engineering scale, commercial scale etc)

5. Commercialisation (licensing, royalty, spin-off, direct sale etc)

iii. General Comment (please provide additional information, if any, on the future direction of this project in terms of its prospects to commercialization)

All 3 milestones were successfully achieved including milestone no.3 where Oil Palm Ash can be used as reinforcing filler to replace commercial fillers such as carbon black and silica in natural rubber products. However, the filler loading used was not more than 10 phr.
### Description of the Project

1. **Project number**: 03-01-05-SF0491
2. **Project Title**: Potential of oil palm ash as a new filler in natural rubber compounds
3. **Project Leader**: Hanafi Ismail
4. **Project Team**:
   (please provide an assessment of how the project team performed and highlight any significant departures from plan in either structure or actual man-days utilised)
   All the project team members are in School of Materials and Mineral Resources Engineering, Engineering Campus, USM, Nibong Tebal, Penang
5. **Industrial Partnership**:
   (Please describe the nature of collaborators with relevant industry)
   United Oil Palm Industries Sdn Bhd - provide the oil palm ash for research project.
6. **National/International Collaboration**:
   (Please identify research organisations and describe the nature of collaboration)
7. **Project Duration**:
   **Start date**: October (month) 2011 (year)
   **End date**: September (month) 2013 (year)
8. **Total Budget Approved**: RM 183504
B. Objectives of the Project

1. Socio-economic Objectives (SEO)
Which socio-economic objectives are addressed by the project? (Please identify the Research Priority Area, SEO Category and SEO Group under which the project falls. Refer to the Malaysian R&D Classification System, 4th Edition.

<table>
<thead>
<tr>
<th>Research Priority Area</th>
<th>SEO Category</th>
<th>SEO Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>INDUSTRY</td>
<td>Natural Sciences, Technologies and Engineering</td>
<td>Applied Sciences and Technologies</td>
</tr>
</tbody>
</table>

2. Fields of Research (FOR)
Which are the two main FOR Categories, FOR Groups, and FOR Areas of your project? (please refer to the Malaysian R&D Classification System, 4th Edition)

a. Primary field of research

<table>
<thead>
<tr>
<th>FOR Category</th>
<th>FOR Group</th>
<th>FOR Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental Sciences</td>
<td>Applied Sciences and Technologies</td>
<td>Other environment technology/ industry</td>
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</table>

b. Secondary Field of research

<table>
<thead>
<tr>
<th>FOR Category</th>
<th>FOR Group</th>
<th>FOR Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material Sciences</td>
<td>Polymeric Materials</td>
<td>Polymer composites</td>
</tr>
</tbody>
</table>

C. Objective Achievement

- **Original project objectives**
  (Please state the specific project objectives as described in Section II of the Application Form)

The aim of the study is to investigate the properties of oil palm ash (OPA) filled in natural rubber compounds which will be compounded using a conventional two roll mill followed by compression molded. Specifically, the objectives of the study are:

1. To utilize the OPA as a new filler in natural rubber compounds and study the effect of OPA loading on curing characteristics, tensile properties, thermal properties, swelling behavior, morphology of tensile fracture surface and Fourier transform infrared (FT-IR) of the palm oil ash filled natural rubber compounds.

2. To evaluate the effect of modification of OPA on the properties of natural rubber compounds in term of curing characteristics, tensile properties, thermal properties, swelling behavior, morphology of tensile fracture surface and Fourier transform infrared (FT-IR) of the OPA filled natural rubber compounds.

3. To determine the potential application of OPA filled natural rubber compounds.

- **Objective Achieved**
  (Please state the extent to which the project objectives were achieved)

All original objectives were achieved.

- **Objectives not achieved**
  (Please identify the objectives that were not achieved and give reasons)

N/A
<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
</table>
| D. | Technology Transfer / Commercialisation Approach, If any.  
(Please describe the approach planned to transfer/commercialise the results of the project) |
| E. | Assessment of Research Approach  
(Please highlight the main steps actually performed and indicate any major departure from the planned approach or any major difficulty encountered)  
Research approach was done according to initial proposed project. |
| F. | Assessment of the Project Schedule  
(Please make any relevant comment regarding the actual duration of the project and highlight any significant variation from plan)  
The project was completed according to the milestone even though the 2nd year allocation was not received on time. |
| G. | Assessment of Project Cost  
(Please comment on the appropriateness of the original budget and highlight any major departure from the planned budget)  
Although RM 189,504.00 was approved for this project, but the allocation for 2nd year RM136,985.00 was only received at the end of December 2012 and not according to the original budget allocated.  
However, the allocation was used accordingly and the balance at the end of this project was RM 62.89.  
(Statement from Bendahari USM as shown in appendix A) |
| H. | Additional Project Funding Obtained  
(In case of involvement of other funding sources, please indicate the source and total funding provided) |
I. Benefits of the Project

(please identify the actual benefits arising from the project as defined in Section III of the Application form. For examples of outputs, organisational outcomes and sectoral/national impacts, please refer to Section III of the Guidelines for the Application of R&D Funding under ScienceFund)

1. Direct Outputs of the Project

(Please describe as specifically as possible the outputs achieved and provide an assessment of their significant to users)

i. Technical contribution of the project

   a. What was the achieved direct output of the project:
      
      For basic oriented research projects?
      
      - Algorithm
      - Structure
      - Data
      - Other, please specify:

      For applied research (technology development) projects:
      
      - Method/technique
      - Demonstrator/prototype
      - Product/component
      - Process
      - Software
      - Other, please specify:

   b. How would you characterise the quality of this output?
      
      - Significant breakthrough
      - Major improvement
      - Minor improvement

ii. Contribution of the project to knowledge

   a. How has the output of the project been documented
      
      - Detail project report
      - Products/process specification documents
      - Other, please specify:

   b. Did the project create an intellectual property stock?
      
      - Patent obtained
      - Patent pending
      - Patent application will be filed
      - Copyright

   c. What publications are available?
      
      | Publication Type | National | International |
      |------------------|----------|---------------|
      | Article(s) in scientific publications | How many: 0 | 8 |
      | Paper(s) delivered at conferences/seminars | How many: 5 | 4 |
      | Book | How many: 0 | 0 |
      | Other, please specify: | | |
d. How significant are citations of the results?

- Citations in national publications: 0
- Citations in international publications: 4
- Not yet
- Not known

2. Organisational Outcomes of the Project

(Please describe as specifically as possible the organisational benefits arising from the project and provide an assessment of their significance)

i. Contribution of the project to expertise development

a. How did the project contribute to expertise?

- PhD degrees: 1
- MSc degrees: 1
- Research staff with new specialty: 0

b. How significant is this expertise?

- One of the key areas of priority for Malaysia
- An important area, but not a priority one

ii. Economic contribution of the project?

a. How has the economic contribution of the project materialised?

- Sales of manufactured product/equipment
- Royalties from licensing
- Cost savings: RM0
- Time savings
- Other, please specify:

b. How important is this economic contribution?

- High economic contribution: RM0
- Medium economic contribution: RM0
- Low economic contribution: RM0

C. When has this economic contribution materialised?

- Already materialised
- Within months of project completion
- Within three years of project completion
- Expected in three years or more
- Unknown
iii. Infrastructural contribution of the project

a. What infrastructure contribution has the project had?

- New equipment
- New/improved facility
- New information networks
- Other, please specify:

Value RMO: RM0

Investment: RM0

b. How significant is this infrastructure contribution for the organisation?

- Not significant/does not leverage other projects
- Moderately significant
- Very significant/significantly leverages other projects

iv. Contribution of the project to the organisation's reputation

a. How has the project contributed to increasing the reputation of the organisation

- Recognition as a Center of Excellence
- National award
- International award
- Demand for advisory services
- Invitations to give speeches on conferences
- Visits from other organisations
- Other, please specify:

b. How important is the project's contribution to the organisation's reputation?

- Not significant
- Moderately significant
- Very significant

3. National Impacts of the project

(If known at this point in time, please describe as specifically as possible the potential sectoral/national benefits arising from the project and provide an assessment of their significance)

i. Contribution of the project to organisational linkages

a. Which kinds of linkages did the project create?

- Domestic industry linkages
- International industry linkages
- Linkages with domestic research institutions, universities
- Linkages with international research institutions, universities

b. What is the nature of the linkages?

- Staff exchanges
- Inter-organisational project team
- Research contract with a commercial client
- Informal consultation
- Other, please specify:
ii. Social-economic contribution of the project

a. Who are the direct customer/beneficiaries of the project output?

<table>
<thead>
<tr>
<th>Customers/beneficiaries</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Palm Oil Industries</td>
<td>50</td>
</tr>
<tr>
<td>Total</td>
<td>50</td>
</tr>
</tbody>
</table>

b. How has/will the socio-economic contribution of the project materialised?

- [ ] Improvements in health
- [ ] Improvements in safety
- [x] Improvements in the environment
- [ ] Improvements in energy consumption/supply
- [ ] Improvements in international relations
- [ ] Other, please specify:

c. How important is this socio-economic contribution?

- [ ] High social contribution
- [x] Medium social contribution
- [ ] Low social contribution

d. When has/will this social contribution materialised?

- [ ] Already materialised
- [ ] Within three years of project completion
- [x] Expected in three years or more
- [ ] Unknown

Date: 2/1/2004
Signature: [Signature]