No.

マレーシア国
未利用資源飼料化計画フォローアップ
終了時評価報告書

平成 16 年 2 月

（2004 年）

独立行政法人　国際協力機構

農業開発協力部

農開園
JR
04-2

序　　文

独立行政法人国際協力機構は、マレーシア国関係機関との討議議事録（Record of Discussions: R/D）に基づき、2002 年 3 月 15 日から 2 年間の予定で、同国農業の主要作物であるオイルパームの茎葉（Oil Palm Frond: OPF）を活用して粗飼料を製造・流通させ、同国の畜産振興を図ることを目的とした技術協力プロジェクト「マレーシア未利用資源飼料化計画フォローアップ」を実施しています。

プロジェクト終了を控え、当機構は、2003 年 12 月 14 日から同 25 日まで、当機構農業開発協力部長　中川和夫を団長とする終了時評価調査団を現地に派遣し、マレーシア側評価チームと合同で、評価 5 項目（妥当性、有効性、効率性、インパクト、自立発展性）を中心に総合評価を行うとともに、今後に向けての提言を取りまとめました。

これらの評価結果は、日本及びマレーシア側双方の評価調査チームによる討議を経て、合同評価報告書としてまとめられ、署名を取り交わした上で、両国の関係機関に提出されました。

本報告書は、同調査団の調査・評価及び協議の結果を取りまとめたものであり、今後広く関係者に活用されることを願うものです。

最後に、本調査の実施にあたり、ご協力頂いたマレーシア側政府関係機関及び我が国の関係各位に厚く御礼申し上げるとともに、当機構の業務に対して、今後とも一層のご支援をお願いする次第です。

2004 年 2 月

独立行政法人国際協力機構
理　事　　鈴木　信毅

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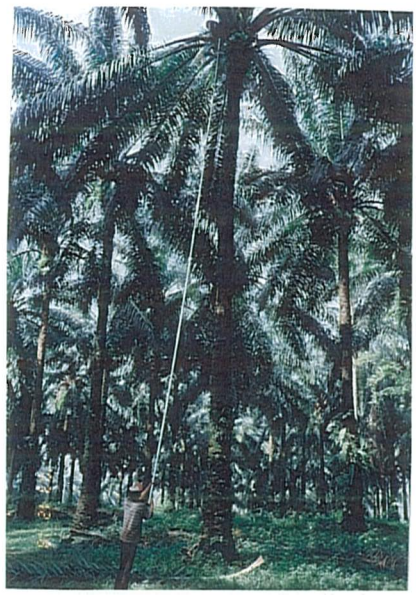

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2.改善前のOPFの収穫・運搬

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7.太陽熱乾燥施設

8.太陽熱乾燥施設

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評価調査結果要約表

I. 案件の概要

国名：マレーシア国		案件名：未利用資源飼料化計画（フォローアップ）
分野：畜産振興		援助形態：技術協力プロジェクト
所轄部署：農業開発協力部畜産園芸課		協力金額：約 50,000 千円
協力期間	(R/D)：1997.3～2002.3	先方関係機関：マレーシア農業開発研究所（ Malaysian Agricultural Research and Development Institute: MARDI ）
	(延長)：	日本側協力機関：農林水産省、独立行政法人国際農林水産業研究センター（JIRCAS）他
	(F/U)：2002.3～2004.3	他の関連協力： 特になし

１．協力の背景と概要

マレーシア国内における畜産物の需要は増加傾向にあるが、同国における畜産業の歴史は浅いため、十分な生産体制が確立されておらず、牛肉の自給率は 25%、乳製品の自給率においては 5%に満たない状況にある。一方、乳牛等の反芻家畜産業の振興には、粗飼料の安定的供給体制の確立が不可欠であるが、粗飼料確保のための新たな草地造成等は森林資源の保護の観点からも困難な状況にある。

このような中、独立行政法人国際農林水産業研究センター（JIRCAS）はマレーシア農業開発研究所（MARDI）とともにマレーシア国の農業における主要作物である油椰子（オイルパーム）の茎葉等を粗飼料として活用するための基礎的な共同研究を約 10 年間行い、オイルパームの粗飼料としての栄養学的価値が確認された。マレーシア政府はこの共同研究の成果を踏まえ、オイルパームの茎葉を利用した粗飼料製造の実用化を図るため、1994 年 10 月、プロジェクト方式技術協力を我が国に要請した。

これを受けて JICA は、農業副産物であるオイルパーム茎葉（Oil Palm Frond: OPF）を利用して粗飼料の安定的供給を図るため、OPF 飼料製造パイロットプラントの開発、OPF 飼料を使用した適切な飼養管理方法の開発等を目的とし、1997 年 3 月より 5 年間の技術協力を実施した。しかし、パイロットプラント設置の遅れ、また OPF が全く新しい加工原料であるという特殊性から OPF 飼料製造パイロットプラントの安定的稼動、OPF 飼料を使用した家畜飼養管理の分野でプロジェクト活動が大幅に遅延した。このため 2001 年に実施された終了時評価において、プロジェクト期間内にプロジェクト目標を達成することは困難と判断されたことから、2002 年 3 月より 2 年間のフォローアップ（F/U）が開始された。

２．協力内容

(1) 上位目標：
オイルパーム産業の農業副産物を利用した飼料の安定供給によってマレーシア国の畜産振興を図る

(2) プロジェクト目標
オイルパーム副産物を飼料に変換する効率的、実用的技術が開発される

(3) 成果
1) オイルパーム茎葉及びその他の副産物を飼料に加工する飼料製造技術が開発される
2) オイルパーム副産物飼料による家畜飼養管理技術が開発される
3) 畜産現場における飼料の適応性が実証される

(4) 投入（評価時点）

日本側：

長期専門家派遣	3 名	機材供与	約 2,700 万円
短期専門家派遣	6 名	ローカルコスト負担	約 2,300 万円
研修員受入	10 名		

相手国側：

カウンターパート配置 35 名

ローカルコスト負担（施設・設備、ローカルコスト負担など合計）

現地通貨 RM 931,648（約 2,800 万円）

II. 評価調査団の概要

調査者	（担当分野： 氏 名	職 位 ）
	総 括	中川 和夫 JICA 農業開発協力部長
	農業機械	加茂 幹男 農業・生物系特定産業技術研究推進機構 近畿中国四国農業研究センター傾斜地基盤部長
	飼料生産	塩谷 繁 農業・生物系特定産業技術研究推進機構 畜産草地研究所家畜生産管理部乳牛飼養研究室長
	計画管理	明隅 礼子 JICA 農業開発協力部畜産園芸課
	評価分析	東野 英昭 株式会社ﾚｯｸｽ･ｲﾝﾀｰﾅｼｮﾅﾙ（コンサルタント）
	2003 年 12 月 14 日～2003 年 12 月 25 日	評価種類：終了時評価

III. 評価結果の概要

１．評価結果の要約

(1) 妥当性：高い。

プロジェクト目標、上位目標とも、マレーシア国の農業政策と合致しており、終了時評価の時点においてもプロジェクトの妥当性は高い。

マレーシア国は、牛肉の 75%・牛乳乳製品の 95%を輸入しており、同国政府はこれらの自給率を高める政策を押し進めており、2010 年までに牛肉・乳製品ともその国内生産量を倍増するとしている。一方、反芻家畜である牛の飼料には繊維質を多く含む牧草・飼料作物等が必須であるが、マレーシアの熱帯湿潤気候に適した良質牧草類は少なく、繊維質飼料不足が同国の反芻家畜の増産を阻んでいる。従って、繊維を多く含む OPF の飼料化は、牛肉・乳製品の国内生産量を向上しようとするマレーシアの国策及び酪農家のニーズと整合している。

また、OPF の利用による粗飼料供給の増加を通じて、マレーシア国の畜産業が発展し、牛肉や牛乳などの自給率が向上することは、将来、マレーシア国民のニーズを満たすことになることと考えられる。

(2) 有効性：F/U 期間における有効性は高い。

1) F/U 期間においては、先の 5 年間のプロジェクトで実施された活動項目の大半が継続された他、未完了であった活動項目が実施された。未完了の活動項目は、太陽熱を利用した乾燥技術の開発、OPF 飼料製造パイロットプラントの改善等である。また、新たに “5S”や“KAIZEN”活動などのプラント管理運営技術が導入された。

これらの技術改善が適確に遂行された結果、“パッケージ”としての OPF 飼料の生産技術が確立され、パイロットプラントに、当初目標の製造能力が備わった。

2) 試験農場、民間農家での家畜飼養試験が行われ、現地の条件に即した飼養技術が開発された。

3) OPF 粗飼料開発の関連分野に於ける論文発表、出版物の作成、展示会の開催などにより、官・民のセクターの関心が高まった。

(3) 効率性：高い。

1) 日・マ両政府による投入は、量、質、タイミングの全てにおいて概ね適切に実施された。日本側の調整員が三カ月ほど不在の時期があったが、長期専門家とカウンターパートの連携により、プロジェクトの運営に支障なく乗り切った。OPF 原材料の収穫、太陽熱乾燥、パイロットプラント内設備改善のための予算が前倒しで執行され、これにより、F/U における活動が円滑に開始された。

2) 長期専門家、短期専門家による技術移転、日本における研修が効果的に組み合わされ、着実な成果を上げた。

(4) インパクト：正のインパクトが見られる。

1) プロジェクト計画時に設定された上位目標については、マレーシア国の畜産振興に言及しており、最終目標に準ずる内容のため、プロジェクトの枠内での達成は難しいと判断される。今後、様々な支援活動と、政府機関の調整が、上位目標の達成に必要である。

2) 家畜用飼料としては新しい素材である OPF を扱い、技術開発を進めてきた結果、多くの技術的知見が得られ、30 以上の論文・出版物としてとりまとめられた。これらの成果により、MARDI は、OPF 飼料の技術普及に自信を深め、インキュベータシステム（技術普及のための助成方式：民間から研修員を募集し、半年から 1 ネプラントで実際に作業をしながら技術を習得させ、新たに OPF 飼料化事業を開始する場合に各種優遇措置を与える）の実施を企画し、来年度より自主的に運営していく計画を策定した。

3) 上記に関連し、MARDI は JICA と連携して現在 3 件の特許（自走式 OPF 収穫機、OPF 混合飼料）を申請中である。

4) プラント勤務のスタッフは、“5S”や“KAIZEN” 活動に熱心に取り組み、プラントの維持管理、安全管理、品質管理など、プラント運営管理の技術的スキルを身に付けただけでなく、組織的、自主的にプラント運営に取りくむようになった。

(5) 自立発展性：マレーシア側による将来の自主運営は可能である。

1) 組織・制度面：MARDI は、およそ 2,800 名のスタッフを有するマレーシア有数の研究機関である。プロジェクトに配置されたカウンターパートは潜在能力にも優れ、プロジェクト活動を通じて十分な経験を積んだ。従って、組織としてプロジェクトを運営していく上での大きな問題は見当たらない。

2) 財政面:技術面： MARDI は、プロジェクト活動に適切な投入を行ってきているが、今後もパイロットプラントに於ける OPF 飼料生産を継続していく上で、原材料の調達・搬送・プラント運営等に多額のコストがかかるため、MARDI に対する財政面での確実な支援が必要条件となる。

3) その他：プロジェクトの便益を持続させるには、インキュベータシステムを通じて、民間セクターに OPF 飼料を普及することが不可欠である。最近、オイルパームプランテーションからの引き合いも増えているが、インキュベータシステムの詳細計画はまだ作成されていない。MARDI から民間セクターに当該の技術が普及するには、まだ若干の時間が必要であると思われる。

２．効果発現に貢献した要因

(1) 計画内容に関すること

プロジェクトの計画策定の細部については、上位目標とプロジェクト目標との乖離、指標の設定、ターゲットグループの不明確さなどの問題が見られたが、プロジェクト実施の妥当性が高く、マレーシア国の実情に合致していたため、活動の推進に意思決定機関の賛同が得られやすかったと思われる。

(2) 実施プロセスに関すること

1) 専門家と現地カウンターパートの協調関係が良好であり、現場の状況を熟知しているスタッフの“知恵”を活かすことが出来る運営体制が構築されていた。

専門家とカウンターパートとの間の打ち合わせが頻繁に行われ、実際に C/P のアイデアが、技術改善に取り入れられた。

2) パイロットプラント勤務のスタッフについては、“５Ｓ”や“KAIZEN”活動の導入で、技術面だけでなく、“心構え”を学んだことにより、組織として機能し、技術向上がより効果的になった。

3) 日・マ両国政府による適確な投入が行われた（長期専門家、短期専門家による技術移転と、日本での研修が効果的に組み合わされたこと、専門性を持ったカウンターパートが配置されたこと等）。

３．問題点及び問題を惹起した要因

(1) 計画内容に関すること

プロジェクトの妥当性は高いものの、計画内容については、ターゲットグループ、上位目標、指標などの設定、論理的な関係に改善すべき部分が有った。特に、指標については、具体性、現実性に欠けた内容であった。

(2) 実施プロセスに関すること

1) パイロットプラントの基本設計における設備のレイアウト、設備の仕様等に、実際の生産活動に合致していない面が見られたため、改善に多くの時間が費やされた。

2) OPF 原料の調達に制限が有った。UPM（国立プトラ大学：MARDI に隣接）のプランテーションを借り上げたが、規模が小さく、また、プラントまでの距離が遠かった。

４．結論

プロジェクト関係者との一連の協議及び現場視察の結果から、日本人専門家、マレーシア側 C/P が一体となって課題に取り組んだ結果、2 年前に行われたプロジェクト終了時評価時に示された提言の内容について、ほぼ解決されたと判断する。

現時点で、残された期間中に解決すべき課題も存在するが、R/D に示された成果とプロジェクト目標については、概ね達成されており、残された課題についても、十分な技術と知識を習得したマレーシア C/P が、独力で対応可能であると考えられる。

従って、プロジェクトは R/D に示された 2004 年 3 月 14 日を以て協力期間を終了する。

５．提言（当該プロジェクトに関する具体的な措置、提案、助言）

(1) プロジェクトチームは、残りのプロジェクト協力期間に、残された課題の解決に全力を尽くすべきである。

(2) MARDI は、プロジェクトを通じて開発された技術の普及を自主的に行うべきである。“インキュベータ”システムの実施と国内の OPF 飼料利用者に対する普及に全力で取り組み、また、第一産業省、財務省等、国内の関係機関との協力関係を構築していくことが重要である。

(3) 2004 年 2 月 17 日に予定されている最終セミナーは、プロジェクトの成果の発表の場としても、また、人々の当該技術への関心を高め、普及戦略を講じる上でも絶好の機会であることに留意し、開催すべきである。

(4) 現在申請中の特許については、MARDI は JICA と協議の上、速やかに取得できるように努力すべきである。また、第三国が当該特許技術の使用を JICA に求めた場合には、JICA と MARDI 間の緊密な協議の上で、対応することとする。

(5) 飼養管理実験は、プロジェクト協力期間終了後も、MARDI の手で継続して実施することが必要である。実験データの数（サンプル数）を増やし、データの信頼性を向上することにより、ユーザーに対して OPF 飼料の利点を、より明確に示すことが可能になるであろう。

(6) 協力期間後に、パイロットプラントを効果的に運営するためには、維持管理システムの構築が重要となる。予算措置と、必要な補充人員の配置を含めた検討を行うべきである。

(7) マレーシア国の畜産振興実現のために、MARDI は、プロジェクトで生み出された個々の技術の最大限の活用手段も検討すべきである。例えば、細断した OPF チップを、それ以上の加工はしないで、そのまま家畜に与えるなど、さまざまな案の検討が必要となろう。

６．教訓（当該プロジェクトから導き出された他の類似プロジェクトの発掘・形成、実施、運営管理に参考となる事柄）

(1) “心構え”や”規律“を指導することにより、カウンターパートへの技術移転をより効果的に発現させることが出来る。パイロットプラントのスタッフは、専門家による技術の適確な移転に加え、“5S”（整理、整頓、清掃、清潔、しつけ）や “KAIZEN”活動への参加から、日常の勤務態度や協力して活動することの重要性に気づき、パイロットプラントの運営を自主的、組織的に行うようになった。

(2) MARDI 内におけるグループ間の連携がプロジェクトの成果に貢献した。例としては、飼養管理実験グループからのフィードバック情報で、一部壊れやすかった OPF-TM キューブの形成技術が向上した。

(3) プロジェクト目標は達成されたものの、プロジェクト計画策定時に設定された上位目標は、プロジェクトの枠内では、達成が出来ない内容であると考えられる。より現実的な上位目標の設定のための検討が、関係者、計画者、実施者により行われるべきであった。

第１章　終了時評価調査団の概要

１－１　調査団派遣の経緯と目的

(1) 経緯

マレーシア国内における畜産物の需要は増加傾向にあるが、同国における畜産業の歴史は浅いため、十分な生産体制が確立されておらず、牛肉の自給率は 25%、乳製品においては 5%に満たない状況にある。乳牛などの反芻家畜の産業振興には、粗飼料の安定的供給体制の確立が不可欠であるが、粗飼料確保のための新たな草地造成などは森林資源保護の観点からも困難な状況にある。

独立行政法人国際農林水産業研究センター（JIRCAS）は、こうした状況を改善するためマレーシア農業開発研究所（MARDI）とともにマレーシア国の農業における主要作物である油椰子（オイルパーム）の茎葉などを粗飼料として活用するための基礎的な共同研究を約 10 年間行い、オイルパームの粗飼料としての栄養学的価値を確認した。マレーシア政府はこの共同研究の成果を踏まえ、オイルパームの茎葉を利用した粗飼料製造の実用化を図るため、1994 年 10 月、プロジェクト方式技術協力を我が国に要請した。

これを受けて JICA は、OPF（Oil Palm Frond）を利用して粗飼料の安定的供給をめざすための OPF 飼料製造プラント開発、OPF 飼料の適切な飼養管理法開発などの技術協力を 1997 年 3 月より 5 年間実施した。しかし、プラントの設置が遅れたことや、OPF が全く新しい加工原料であるという特殊性が原因となり、OPF 飼料製造プラントの安定的稼動に至らなかったためプロジェクト活動が大幅に遅延した。このため 2001 年に実施された終了時評価において、プロジェクト期間内にプロジェクト目標を達成することは困難と判断されたことから、2002 年 3 月より 2 年間のフォローアップ（F/U）が開始された。

今般、2004 年 3 月 14 日の活動期間終了に向けて、これまでの活動実績を評価するとともに、今後に向けての提言及び教訓を抽出することを目的に、終了時調査団を派遣した。

(2) 調査団の目的

1) 技術協力フォローアップの開始から 2 年間の実績（調査団訪問後の予定を含む）と計画達成度を討議議事録（R/D)、暫定実施計画、及び PDM などに基づき、評価 5 項目（妥当性、有効性、効率性、インパクト、自立発展性）に沿って総合的に調査、評価する。

2) 技術協力期間終了後に取るべき措置について協議し、その結果を日本、マレーシア両国政府及び関係当局に報告・提言する。

3) 今後、類似案件を効率的に立案・実施するため、本協力の実施による教訓・提言を取りまとめる。

１－２　調査団の構成

1）総括　　中川　和夫　　独立行政法人国際協力機構 農業開発協力部　部長
2）農業機械　　加茂　幹男　　独立行政法人農業・生物系特定産業技術研究機構
近畿中国四国農業研究センター　傾斜地基盤部　部長
3）飼料生産　　塩谷　　繁　　独立行政法人農業・生物系特定産業技術研究機構
畜産草地研究所 家畜生産管理部　乳牛飼養研究室　室長
4）計画評価　　明隅　礼子　　独立行政法人国際協力機構 農業開発協力部畜産園芸課　職員
5）評価分析　　東野　英昭　　株式会社レックス・インターナショナル（コンサルタント）

１－３　調査日程

2003 年（平成 15 年）12 月 14 日～12 月 25 日

日時		訪問先	日本側評価調査団	ﾏﾚｰｼｱ側評価調査団
12/14	10:30	成田発(MH089)		
(日)	17:05	クアラルンプール到着 (東野団員のみ)		
12/15		インタビュー調査 (東野団員のみ)	○	
(月)				
12/16		インタビュー調査 (東野団員のみ)	○	
(火)	10:30	成田発(MH089)		
	17:05	クアラルンプール到着 (中川団長、加茂団員、塩谷団員、明隅団員)		
12/17	09:00	JICA マレーシア事務所打合せ	○	
(水)	10:20	日本大使館表敬	○	
	11:30	マレーシア農業省表敬	○	
	15:00	MARDI Director-General 表敬	○	
	16:00	日本人専門家との打合せ	○	
12/18	09:30	合同評価委員会 (評価方法説明)	○	○
(木)	11:00	オイルパーム園及びプラント視察	○	○
	15:00	プレゼンテーション (Review of Activities)	○	○
12/19	08:30	合同評価委員会 (Reviews of Activities)	○	○
(金)	15:00	日本人専門家との打合せ及び団内打合せ	○	
12/20		評価レポート作成	○	
(土)				
12/21		団内打合せ及び日本人専門家との打合せ	○	
(日)				
12/22	09:30	合同評価委員会	○	○
(月)				

12/23	09:30	合同調整委員会（Joint Coordinating Committee: JCC）準備	○	○
(火)	14:30	JCC、ミニッツ署名・交換	○	○
12/24	11:00	経済企画局（Economic Planning Unit: EPU）報告	○	
(水)	15:00	オイルミル見学	○	
12/25	11:05	クアラルンプール発(MH070)		
(木)	18:35	成田着		

１－４　主要面談者

＜マレーシア側＞

(1) マレーシア農業開発研究所（MARDI）

Y. Bhg. Datuk Dr. Saharan bin Hj. Anang	Director General
Mr. Ahmad Tajuddin bin Zainuddin	Director, Economy and Technology Management Research Center
Dr. Mohd. Khusahry Mohd. Yusoff	Director/Project Manager, Strategic Livestock Research Center
Dr. Engku Azahan Engku Ahmad	Assistant Director/Assistant Project Manager, Strategic Livestock Research Center
Mr. Mat Daham Mat Daud	Station Management Center
Dr. Mohd. Jaafar Daud	Strategic Livestock Research Center
Dr. Wan Zahari Mohamed	Project Coordinator, Strategic Livestock Research Center
Mr. Sarmin b. Sukir	Economy and Technology Management Research Center

(2) マレーシア農業省

Mr. Sukandar Abdul Latif	Undersecretary, Strategic Planning and International Division
Ms. Wan Azizah wan Jaffar	Principal Assistant Secretary, International Section, Strategic Planning and International Division
Mr. Tuan Haji Idris Abu Bakar	Industry Development, Department of Veterinary Services

(3) マレーシア経済企画庁（EPU：援助窓口機関）

Ms. Harvider Kaur	Senior Director, Agriculture Section

＜日本側＞

(1) 在マレーシア日本大使館

細野　真一	参事官
山崎　敬嗣	一等書記官

(2) JICA マレーシア事務所

樋田　俊雄	所長
佐々木十一郎	次長
植木　雅浩	所員

(3) マレーシア国未利用資源飼料化計画フォローアップ・プロジェクト専門家

佐藤　純一	チーフアドバイザー／家畜管理
赤松　志保	業務調整
古市　信吾	農業機械

１－５　終了時評価の方法

(1) 合同評価

日本側評価調査団は、マレーシア側評価委員と合同評価委員会を結成し、カウンターパート機関（MARDI）へのインタビュー調査・協議、現地視察などを行い、評価 5 項目に沿って総合的に評価調査を実施した。評価結果は合同評価報告書として取りまとめ、合同調整委員会にて報告した。また、合同調整委員会の協議結果をミニッツに取りまとめ、署名・交換を行った。

＜マレーシア側評価委員＞

1) Machinery (Co-chairperson of Joint Evaluation Committee)
Dr. Ibni Hajar b. Rukunudin
Director, Mechanization & Automation Research Center, MARDI

2) Animal Nutrition
Dr. Abdul Razak Alimon
Assoc. Prof., Department of Animal Science, University Putra Malaysia

3) Animal Feeds/Livestock
Dr. Vincent Ng
Director, Commodity Division, Department of Veterinary Services, Ministry of Agriculture

4) Economy

Dr. Y.M. Tengku Ariff b. Tengku Ahmad
Deputy Director, Economic and Technology Management Research Centre, MARDI

(2) プロジェクトデザインマトリックス（PDMe）の策定

評価用プロジェクト・デザイン・マトリックス（PDMe）は、2001 年に実施された前回の終了時評価後にプロジェクト目標の指標（「技術体系の確立」及び「OPF 飼料問い合わせ件数」）を追加したものを使用した（付属資料 1 及び付属資料 2 の Annex4 を参照）。

成果 1. の「オイルパーム茎葉及びその他の副産物を飼料に加工する飼料製造技術が開発される」の指標「プラントから年間 2 千トンの OPF 飼料が生産される」については、OPF の材料供給源が限られていたことや、プラントが試験・研究目的に使用されていたこと、プラントの年間稼動が現実的には不可能であったことなどの理由により、パイロットプラントの能力を測るのは物理的に不可能であると判断された。したがって、合同評価委員会での合意の下で、当初の指標にかえて OPF 収穫作業技術やプラントの太陽熱乾燥技術、時間当たりの飼料製造能力など個々のコンポーネントでの実証値から理論上の年間生産量を推計して評価を行った。

(3) 評価の方法

日本・マレーシア双方の評価委員から成る合同評価チームは、カウンターパート機関である MARDI におけるインタビュー調査・協議に基づいてプロジェクトの進捗と課題を調査し、PDMe に照らしてプロジェクト達成度を把握した。それらに加えて、農業省などの関係機関との協議・意見交換並びに現地視察を行い、評価 5 項目（妥当性、有効性、効率性、インパクト、自立発展性）の観点から判断した総合評価結果を合同評価報告書に取りまとめた。

第２章　プロジェクトの進捗状況について

２－１　プロジェクトの概要

(1) 上位目標

オイルパーム産業の農業副産物を利用した飼料の安定供給によってマレーシア国の畜産振興を図る。

(2) プロジェクト目標

オイルパーム副産物を飼料に変換する効率的、実用的技術が開発される。

(3) 成果

1) オイルパーム茎葉及びその他の副産物を飼料に加工する飼料製造技術が開発される。
2) オイルパーム副産物飼料による家畜飼養管理技術が開発される。
3) 畜産現場における飼料の適用性が実証される。

(4) 活動内容

1) 飼料製造法の改良（原料供給）
   a) 原料収穫・収集技術を開発する。
   b) 原材料のハンドリング・輸送方法の改善を行う。
   c) 原料前処理法を改善する。
2) 飼料製造法の改良（飼料製造プラント）
   a) 設計・施工を実施する。
   b) 製造工程を改良する。
   c) プラント運営管理の評価を実施する。
3) 飼料の品質改善・評価の実施
   a) 原材料分析を実施する。
   b) 製造粗飼料の成分分析を行う。
   c) 飼料栄養を改善する。
   d) 製品の評価を行う。
4) 家畜飼養管理技術の改善
   a) 飼養試験設計を行う。
   b) 飼養試験を実施する。
   c) 飼養技術を改善する。
   d) 飼養管理技術の評価を行う。
5) 製造飼料の経済評価
   a) 飼料コストの分析を行う。
   b) 飼料の市場評価を実施する。

２－２　投入実績

投入の詳細は、ミニッツ（付属資料 2）を参照されたい。

(1) 日本側の投入

1) 専門家派遣

計 3 名の長期専門家及び計 6 名の短期専門家が派遣された。

2) 機材の供与

太陽熱乾燥関連機材、OPF ミキサーなどの機材が供与され、プロジェクト目標の達成のために効果的に使用された。

3) カウンターパート研修受入

計 10 名のカウンターパートが日本で研修を受けた。カウンターパート研修は、短期専門家派遣と連携して行われ、技術移転の促進に大きな役割を果たした。

4) ローカルコスト負担

プロジェクトのローカルコストの一部を日本側が負担した。

(2) マレーシア側の投入

1) カウンターパート、事務職員の配置

マレーシア側は、プロジェクトの実施期間中に計 35 名のカウンターパートを配置した。この中で 5 名のカウンターパートはフォローアップ期間中に新たに配置された。また、事務職員及び運転手についても、プロジェクトの円滑な実施のために協力して業務を行った。

2) ローカルコスト負担

プラント稼動やメンテナンスのための費用の一部がマレーシア側によって負担された。この中には、機材修理、原料供給、燃料、飼料用袋、その他の消耗品が含まれる。

また、Intensive Research Priority Area(IRPA)プロジェクトの基金がプロジェクト活動のために利用された。この基金により、実験、分析、交通費、日当、人件費、機材修理、セミナー開催・参加に係る費用などがまかなわれた。

２－３　プロジェクト目標の達成度

(1) プロジェクト目標の達成度

プロジェクト目標：オイルパーム副産物を飼料に変換する効率的、実用的技術が開発される。

F/U 期間中に当初のプロジェクト目標を達成することができたと結論づけられる。

各コンポーネント（材料供給、乾燥、プラント成形、飼養試験など）の改良を通じて、OPF を材料とした飼料の質が向上した。確立された技術は、エンドユーザーへは十分に普及していないものの関係者の関心を引き付けており、今後の技術普及のためには飼養試験及びデータの収集が引き続き必要である。また、ユーザーの信頼については、飼養試験により部分的に実証されている。

(2) 成果の達成度

成果１：OPF 及びその他の副産物を飼料に加工する飼料製造技術が開発される。 指標　：①プラントから年間 2 千トンの OPF 飼料が生産される。 　　②既存飼料相当の品質を有する。

OPF の材料供給源が限られていたこと、プラントが試験/研究目的に使用されていたこと、OPF 飼料の需要が現時点では十分にないこと等の理由により、指標　の達成は困難であった。しかしながら、F/U 期間中に新収集作業技術や太陽熱乾燥技術の開発により大幅に飼料製造の能率が向上し、1 時間当たり 2 トンに達したことから、プラントは年間生産量 2 千トンを達成できる性能となったと結論づけられる。

また、ICP-MS で分析した OPF 飼料中の鉛含量は、日本の安全基準（3mg/kg）以下であり、指標②は達成された。

成果２：オイルパーム副産物飼料による家畜飼養管理技術が開発される。 指標　：肉牛・乳牛の OPF 家畜管理技術の標準化

肉牛については、大規模なオイルパームプランテーションにおいて OPF 混合飼料（OPF-TM 飼料）を給与した結果、対照区の 2 倍近い増体を示した。また、乳牛については、小規模酪農家において OPF 混合飼料の飼養試験を行った結果、産乳量の増加に効果が見られた。

プロジェクト期間中に、OPF 給与による家畜飼養試験のデータを基に、肉牛及び乳牛の飼養管理マニュアルが策定されており、指標は達成されたと判断される。

成果３：畜産現場における飼料の適応性が実証される。 指標　：市場競争力

パイロットプラントの OPF 飼料製造コスト分析により、OPF-TM 飼料は 1 トン当たり 414RM であるが、OPF 完全飼料は 1 トン当たり 157RM という結果となった。これは、マレーシア国内において、米糠、干草、小麦等の飼料の市場価格より安価であり、市場競争力はあると判断できる。

(3) 上位目標達成の見込み

上位目標：オイルパーム産業の農業副産物を利用した飼料の安定供給によってマレーシア国の畜産振興を図る。

プロジェクト目標と上位目標の間に乖離が大きく、当初設定された上位目標は、プロジェクトの枠組みの中では短期間に達成することが困難であると考えられる。それゆえ、上位目標達成のためには、関係機関が連携し、長期間にわたって様々な支援活動を行うことが必要となる。

特に、プロジェクト期間中に開発された技術であるインキュベーターシステムを、他の関係機関と連携した上で普及させることが、上位目標達成には不可欠である。

２－４　各分野の達成度

TSI に沿って各活動の達成状況を調査したところ、下記の活動 1〜5 に係る達成度は以下のとおりである。

活動 1. 材料供給と太陽熱乾燥システム
活動 2. OPF 乾燥成形実験プラント
活動 3. 飼料品質の改善
活動 4. 飼養管理技術の改善
活動 5. 経済評価

活動 1. 材料供給と太陽熱乾燥システム

F/U 活動以前の本体プロジェクトでは、人力を主体とする中小型機械化システムの開発が行われたが、OPF 乾燥成形パイロットプラントの生産能力を下回っていた。このため、F/U 期間中、複数作業が同時に行える高能率機械化システムの開発が取り組まれた。開発された OPF ハーベスターは、オイルパーム農園内において OPF の拾い上げとともに、細断、荷受けの各作業を同時に行い、荷下ろし作業を円滑に行えるようになった。開発した OPF ハーベスターの作業能率はほぼ人力 30 人分に匹敵し、パイロットプラントの大規模生産能力に十分対応できるものである。

太陽熱乾燥システムについては、F/U 活動期間中に乾燥面に対して 45 度傾けた大型送風機が設置され、自動攪拌・混合装置の攪拌・運行方式を改善した新しい太陽熱乾燥ハウスが開発された。新たな太陽熱乾燥ハウスの乾燥能力は、本体プロジェクトの開始時に導入された太陽熱乾燥ハウスの 5〜10 倍に匹敵し、これらの改良によって人工乾燥工程における乾燥経費が大きく節減された。

活動 2. OPF 乾燥成形実験プラント

F/U の活動期間中は、本体プロジェクトにおいて導入された OPF 乾燥成形パイロットプラントの各機械装置が OPF 材料に適合できるよう改造する計画が検討され、必要な改造・改良が実施された。その結果、OPF 成形飼料の安定した製造が可能になった。それに加えて、安全、保守、及び品質などを含めたパイロットプラントの管理が、日本の「5S（整理、整頓、清掃、清潔、しつけ）活動」や「KAIZEN 活動」などの工場管理技術の導入によって大きく改善された。

新たな太陽熱乾燥システムによって乾燥能力の向上と安定化が実現されたが、人工乾燥工程における初期水分は太陽熱乾燥時の気象条件によって大きく影響されることから、残された F/U の活動期間内に、初期水分に影響されない人工乾燥技術を確立することが重要である。

活動 3. 飼料品質の改善

飼料品質の改善に関わる全ての項目は、F/U 期間中にスケジュール通り達成された。

ICP-MS（誘導結合プラズマ質量分析装置）で分析した OPF 飼料中の鉛含量は、日本の安全基準（3mg/kg）以下であった。肉牛及び乳牛用飼料として最適な OPF Total Mixture 飼料中の OPF 混合割合は、30%であった。OPF 製造工程における品質安定生産技術の確立のために品質管理マニュアルが作られた。

活動 4. 飼養管理技術の改善

飼養管理技術の改善に関わる全ての項目は，F/U 期間中にスケジュール通りに達成される見込みである。

試験場及び農家における飼養試験の結果から、OPF 混合成形飼料（OPF-TM-Cube）は養分バランスが良く乳牛及び肉牛生産に適していることが示された。

OPF-TM 飼料を用いた飼養法と慣行飼養法とを比較した試験の結果は次のとおりである。

a) 乳牛において、産乳量と牛乳成分に差が認められず、OPF-TM 飼料は飼養管理の省力化に有効であった。

b) 肉牛において、小麦、Palm Kernel Cake(PKC)、牧草などを食べさせた牛の平均日増体量が 0.24kg/日に対し、OPF-TM 飼料を給与した牛の平均日増体量は 0.93kg/日であった。

c) OPF-TM 飼料の給与により、体重 200kg から 320kg までの肥育期間を 500 日から 129 日まで短縮することができた。

d) OPF-TM 飼料の給与により、と体重が 107kg から 109kg に、また、ロース芯面積が 7.4cm^2 から 8.1cm^2 に増加した。

マレーシア国内における飼養管理マニュアルの利用範囲の拡大に向けて、様々な地域条件や飼養形態の下で飼養試験を継続する必要がある。

活動 5. 経済評価

OPF 成形飼料の製造コスト分析が行われ、その結果をもとに、製造コストの一層の低減化と OPF 乾燥成形パイロットプラント効率化のためのシステム改良が実行された。また、OPF-TM-Cube を活用する畜産経営モデルが構築された。

第３章　評価結果

３－１　妥当性

プロジェクト目標、上位目標とも、マレーシア国の農業政策と合致しており、終了時評価においてもプロジェクトの妥当性は高い。

マレーシア国は、牛肉の 75%・乳製品の 95%を輸入に依存しているため、同国政府はこれらの自給率を高める政策を押し進めており、2010 年までに牛肉・乳製品ともその国内生産量を倍増するとしている。反芻家畜である牛の飼料には繊維質を多く含む牧草･飼料作物等が必須であるが、マレーシアの熱帯湿潤気候の適した良質牧草類は少なく、繊維質飼料不足が同国の反芻家畜の増産を阻んでいる。したがって、繊維を多く含む OPF の飼料化は、牛肉・乳製品の国内生産量を向上しようとするマレーシアの国策及び酪農家のニーズと整合している。

また、OPF の利用による粗飼料供給の増加を通じてマレーシア国の畜産業が発展し、牛肉や乳製品などの自給率が向上することは、将来マレーシア国民のニーズを満たすことになると考えられる。

マレーシアにおいては、350 万 ha のオイルパーム園から年間 1,100 万トンに達するパームオイルを生産しており、極めて重要な産業である。オイルパーム果実収穫時に切り落とされる OPF は使途がなく、大量のバイオマスとして放置されるので、病害虫の温床となる。OPF はまた CO2 への分解は、農業環境ばかりでなく地球環境への影響も懸念されるため、OPF の有効利用は土地生産性を向上するばかりでなく、環境対策にも結びつくことから日本側援助政策との整合性も高い。

３－２　有効性

F/U 期間におけるプロジェクトの有効性は高い。

F/U 期間中は、ほぼ全専門分野にわたるプロジェクト活動課題を前 5 年間本体プロジェクトから引き継ぐとともに、残された課題への取り組みが効率的に遂行された。残された課題は材料供給と太陽熱乾燥システムにおける乾燥能力の向上と安定化であり、OPF 乾燥成形実験プラントの改良・改造及びプラントの新たな保守管理技術の導入などである。

太陽熱乾燥システムや OPF 乾燥成形パイロットプラントの改造・改良に取り組んだ結果、収穫から乾燥成形までの総合的な OPF 乾燥成形技術が確立され、安定した OPF 成形飼料の生産が可能となった。したがって、OPF 乾燥成形パイロットプラントは、到達目標能力を達成するのに十分な技術的かつ潜在的能力を有しているといえる。加えて、「5S 活動」や「KAIZEN 活動」などの工場保守管理技術の導入により、実験プラントの運営担当者達は安全、保守及び品質についての管理技術を修得し、意識の向上も図った。

また、OPF 飼料の給与試験が試験場と個人農場で実施された結果、実用的な飼養技術が開発された。

関連分野における発表や印刷物、説明会などを行い、公的機関及び民間部門の両方から多くの注目を集めた。

３－３　効率性

F/U 期間におけるプロジェクトの効率性は高い。

F/U 期間中は、プロジェクトの実行に必要な資材は、日本及びマレーシア両国によってタイミング良く投入され、各種の技術的側面において重要な改良・改造が効率的に実行された。日本側は、2003 年 6 月から 2003 年 9 月までの 3 カ月間コーディネーターの不在期間があったが、長期派遣専門家及び C/P スタッフはお互いに助け合ってプロジェクト活動の遂行にあたった。OPF ハーベスターの開発や太陽熱乾燥施設の改造に係わる予算は、F/U の開始とともに迅速な取り組みが行えるように、5 年間本体プロジェクトの最終年に先行して割り当てられている。

３－４　インパクト

プロジェクト実施の作用により正の効果が見られる。

(1) 上位目標はプロジェクト計画時に設定されたが、プロジェクトの枠内で達成するのが困難と考えられる。それゆえ、上位目標の達成には長い期間や様々な支持活動ならびに政府関係諸機関の協力などが必要である。

(2) 家畜用飼料として未利用の新しい資源である OPF の処理加工技術の開発により、様々な科学的発見や技術が成果として生み出された。このような科学的発見や技術開発に基づき、プロジェクトに関連した論文や資料が 30 以上も提出されている。これらの事実は、OPF 生産における MARDI の自信を確固たるものにした。結果として、MARDI は自らの手で技術普及を図り、産業界に技術を移転するための「インキュベーター・システム」の創設を決定した。

(3) 科学的発見や技術開発に基づき、3 種類の特許出願を JICA と協力して MARDI により SIRIM（Standards and Industry Research Institute, Malaysia）に提出した。プロジェクト活動を通じて得られた知的財産は、将来的に MARDI の財政基盤の強化につながると期待される。

パイロットプラントのスタッフは、安全管理や維持管理ならびに「5S 活動」や「KAIZEN 活動」を通した品質管理やその技術移転を含むプラント管理術も獲得した。このことは、パイロットプラントのスタッフ間の相互理解を高め、協力体制を作り上げるための大きな要因となった。

３－５　自立発展性

マレーシア側による自主運営は将来的には十分可能である。

(1) 組織・制度面：MARDI は、およそ 2,800 名のスタッフを有するマレーシア有数の研究機関である。プロジェクトに配置された C/P は潜在能力にも優れ、プロジェクト活動を通じて十分な経験を積んだ。したがって、組織としてプロジェクトを運営していくうえでの大きな問題は見当たらない。

(2) 財政面・技術面：MARDI はプロジェクト活動に適切な投入を行ってきているが、今後もパイロットプラントにおける OPF 飼料生産を継続していくうえで、原材料の調達・搬送・プラント運営などに多額のコストがかかるため、MARDI に対する財政面での確実な支援が必要条件となる。

(3) プロジェクトの便益を持続させるには、インキュベーターシステムを通じて民間セクターに OPF 飼料を普及することが不可欠である。最近、オイルパームプランテーションからの引

き合いも増えているが、インキュベーターシステムの詳細計画はまだ作成されていない。MARDI から民間セクターに当該技術が普及するには、若干の時間が必要であると思われる。

第４章　提言と教訓など

４－１　結論

本調査の結果、当初設定されたプロジェクトの課題はほぼ達成されており、一部遅れが見られるものの C/P がプロジェクト終了後も独自に継続できることが確認された。また、前回の終了時評価の提言事項については日本人専門家及び C/P が協力的に対応策を実行に移していることから、プロジェクトは予定通り 2004 年 3 月 14 日をもって終了するのが妥当と判断された。

合同評価委員会はこれらの評価結果を合同評価報告書に取りまとめ、合同調整委員会にて報告した。合同調整委員会は本報告書を承認し、日本・マレーシア双方によりミニッツ（付属資料２）の署名・交換を行った。

４－２　提言

合同評価委員会は、プロジェクトの自立発展性を確保するために、以下の点についてプロジェクトチーム及び MARDI に対する提言を行った。

(1) プロジェクト終了時までの 3 カ月間、引き続き目標達成に向けて努力すること。

(2) プロジェクト活動の成果の普及については、インキュベーターシステムの実施を含め、各関係省庁と連携したうえで、マレーシア側の主体的な取り組みが重要であること。

(3) 2 月 17 日に予定されている最終セミナーについては、多くの関係者に対するプロジェクト成果の広報や、今後の普及発展のための方策について関係者と議論する絶好の機会とするよう努めること。

(4) 現在申請中の特許については､できるだけ早く取得ができるよう JICA 事務所と連携を取りつつ、必要な手続きを行うこと。また、第 3 国から JICA に特許使用申請があった場合には、JICA は MARDI に相談をすること。

(5) プロジェクト期間中及び終了後も飼養試験を継続し、データの信頼性を得るためにサンプル数を増やすこと。

(6) プロジェクト終了後にプラントを効率的に活用するため、財政面、人材面を含め維持管理体制の確立が重要であること。

(7) マレーシアの畜産業振興のために、プロジェクト活動で得られた個々の技術を最大限に利用すること。例えば、細断した OPF チップを成形しないまま家畜に給与することが考えられる。

４－３　教訓

本プロジェクトを通じて得られた教訓としては、以下の点が挙げられる。

(1) プロジェクト期間中に日本人専門家により積極的に紹介された「5S 活動」「KAIZEN 活動」は、スタッフ間の相互理解を促し、スタッフのプラント運営技術に良い影響を及ぼした。ソフト面における効果が相乗効果となって、効率的なプラント改善・改良というハード面での効果をもたらした。

(2) MARDI のセクション間の連携がプロジェクト目標達成に大きく貢献した。例として、飼

養試験担当のセクションからのコメントが OPF 飼料製造にフィードバックされたことが挙げられる。

(3) プロジェクト目標は十分に達成されたが、プロジェクトの計画段階で設定された上位目標については、プロジェクトの時間枠と活動内容では達成が困難であると考えられる。より現実的な上位目標設定のための検討が行われるべきであった。これは、プロジェクトの形成段階でプロジェクト関係者、計画者、実施者が慎重に検討すべきである。

４－４　今後の協力について

マレーシア側は、飼料の新原料として OPF を扱うことによって知り得た技術の有用性、インキュベーターシステムを通しての同技術の普及の重要性を認識し、畜産分野全体に係る助言、技術支援（インキュベーターシステムの促進を含む）を JICA に要請した。調査期間中の合同調整委員会（Joint Coordinating Committee: JCC）において、本調査団が、帰国後にこの要請を本邦関係機関に伝える旨回答したが、関連する課題に総合的に取り組むことが重要であるので、先方の取り組み（普及戦略や畜産振興の中での位置づけなど）や状況を注視しつつ、先方の自立発展を阻害しない範囲で新規の協力については慎重に検討する必要がある。

付属資料

１．プロジェクト・デザイン・マトリックス（PDMe）（和文）

２．ミニッツ及び合同評価報告書

付属資料１

1.プロジェクト・デザイン・マトリックス（PDMe）（和文）
マレーシア国未利用資源飼料化計画評価用 PDM
プロジェクト名：マレーシア国未利用資源飼料化計画　　F/U　　プロジェクト期間：2002 年 3 月～2004 年 3 月
プロジェクト地域：　マレーシア全国　　ターゲットグループ：MARDI スタッフ　　作成　　2003 年 12 月

プロジェクトの要約	指標	入手手段	外部条件
上位目標: オイルパーム産業の農業副産物を利用した飼料の安定供給によってマレ-シア国の畜産振興を図る。	・OPF 飼料の需要		資源の最適利用によって農業生産者の収入を極大化することにより、国家収入と輸出収入に対する農業分野の寄与を増大させるという NAP3 の国家政策に変更がない。
プロジェクト目標: 　オイルパーム副産物を飼料に変換する効率的、実用的技術が開発される。	・一貫した技術体系の確立がなされている。 ・OPF 飼料に関する問い合わせ数が増加する。 ・ユーザーの信頼を得る。	日本人専門家、C/P からの聞き取り 飼料のユーザーからの聞き取り 飼料のユーザーからの聞き取り	オイルパーム生産に影響する災害や新たな害虫が発生しない。 マレーシア国内の畜産製品消費が続伸する。
成果: 1.オイルパーム茎葉及びその他の副産物を飼料に加工する飼料製造技術が開発される。 2.オイルパーム副産物飼料による家畜飼養管理技術が開発される。 3.畜産現場における飼料の適応性が実証される。	1.1 プラントから年間 2 千トンの OPF 飼料が生産される。 1.2 既存飼料相当の品質を有する。 2.肉牛・乳牛の OPF 家畜管理技術の標準化 3.市場競争力	1.1 日本人専門家、C/P からの聞き取り、プラント現場視察 1.2 品質分析結果の内容検討 2.日本人専門家、C/P からの聞き取り、管理技術内容の検討 3.日本人専門家、C/P からの聞き取り	開発された技術が地元産業に受け入れられる。 MARDI（内）の組織に大幅な変更が生じない。 MARDI の予算が削減されない。 OPF 原料価格が異常に高騰しない。

活動: 1.1 飼料製造法の改良 1.1.1 原料供給 (1) 原料収穫・収集技術を開発する。 (2) 原材料のハンドリング・輸送方法の改善を行う。 (3) 原料前処理法を改善する。 1.1.2 飼料製造プラント (1) 設計・施工を実施する。 (2) 製造工程を改良する。 (3) プラント運営管理の評価を実施する。 1.2 飼料の品質改善・評価の実施 (1) 原材料分析を実施する。 (2) 製造粗飼料の成分分析を行う。 (3) 飼料栄養を改善する。 (4) 製品の評価を行う。 2.家畜飼養管理技術の改善 (1) 飼養試験設計を行う。 (2) 飼養試験を実施する。 (3) 飼養技術を改善する。 (4) 飼養管理技術の評価を行う。 3.製造飼料の経済評価 (1) 飼料コストの分析を行う。 (2) 飼料の市場評価を実施する。	投入（F/U 期間） <u>日本側</u> 1.専門家派遣 <u>長期専門家 （3 名）</u> チーフアドバイザー:1(24.0M/M) コーディネーター:1(15.3 M/M) 農業機械:1(24.0 M/M) <u>短期専門家 （5 名）</u> 飼養管理法評価:1(0.9M/M) 安全評価・有害物質分析:1(0.9M/M) プラント機械:1(0.9M/M) 畜産経営シミュレーション:1(0.9M/M) 業務調整:1(6.5 M/M) 家畜管理:1(0.4 M/M) 2.機材、計測器、工具、素材、車両の供与 供与機材 圃場収集作業機関係 約 1,700 万円 OPF 飼料製造プラント改修 約 1,500 万円 3.カウンターパート本邦研修:10 名 (飼養管理評価:1 家畜飼養管理:2 安全分析:1、機械化・乾燥作業:1、 農業機械:1、プラント機械:4) 4.ローカルコスト負担分 約 140 万円	<u>マレーシア側</u> 1.カウンターパート(35 名) プロジェクト・ディレクター:1 プロジェクト・マネージャー:1 飼養管理評価:1 家畜飼養管理:2 安全分析:1 機械化・乾燥作業:1 農業機械:1 プラント機械化:4 総務・事務員 運転手 2. 土地・建物など プラント建屋など OPF 細断作業など 3.ローカルコスト OPF 飼料製造プラント運営経費など	MARDI 側の C/P 配置に大幅な変更が生じない 前提条件: プロジェクトがマレーシア政府及び関係機関に受け入れられる。

付属資料２

２．ミニッツ及び合同評価報告書

MINUTES OF DISCUSSIONS ON THE JOINT COORDINATING COMMITTEE ON THE FINAL EVALUATION FOR THE FOLLOW-UP PROJECT FOR DEVELOPMENT OF TECHNOLOGY RELATED TO THE PROCESSING OF FEED BASED ON AGRO-INDUSTRIAL BY-PRODUCTS OF OIL PALMS IN MALAYSIA

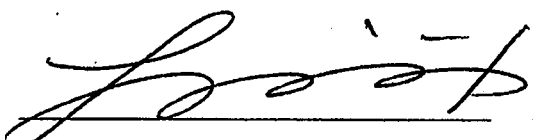
The Japan International Cooperation Agency (hereinafter referred to as "JICA") dispatched the Final Evaluation Team, headed by Mr. Kazuo NAKAGAWA, Managing Director of Agricultural Development Cooperation Department, to Malaysia from December 14 to December 25, 2003, for the purpose of conducting the joint final evaluation for the Follow-up Project of Technology Related to the Processing of Feed Based on Agro-Industrial By-Products of Oil Palms in Malaysia (hereinafter referred to as "the Project").

The Joint Evaluation Committee, which consists of members from JICA and members from the Government of Malaysia, was jointly organized for the purpose of conducting the final evaluation and preparation of necessary recommendations to the respective governments.

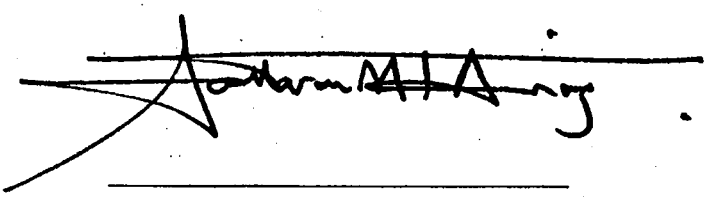
After intensive study and analysis of the activities and achievements of the Project, the Joint Evaluation Committee prepared the Final Evaluation Report (hereinafter referred to as "the Report"), which was presented to the Joint Coordinating Committee.

The Joint Coordinating Committee discussed the major issues pointed out in the Report, and agreed to recommend to the respective governments the matters attached hereto.

December 23, 2003
Kuala Lumpur, Malaysia



Mr. Kazuo NAKAGAWA
Leader
Final Evaluation Team
Japan International Cooperation Agency



Dr. Saharan bin Hj. Anang
Director General
Malaysian Agricultural Research
and Development Institute

ATTACHMENT

1) The Joint Evaluation Committee, which was jointly organized by JICA and the Government of Malaysia, has presented the Report to the Joint Coordinating Committee.

2) The Joint Coordinating Committee has accepted the Report and acknowledged its recommendations to successfully sustain and transfer the findings of the Project to the interested parties.

3) The Malaysian side recognized the usefulness of various scientific findings and engineering technologies generated in OPF handling, a new source of raw material for animal feed and the importance of dissemination of these technologies through the "incubator system" under the leadership of MARDI in close collaboration with Ministries concerned. They also requested JICA to consider continuous advisory and technical support for the overall livestock sector including promotion of "incubator system" for developing the livestock industry in Malaysia.

4) The Japanese side replied that they would convey the request to the authorities concerned after returning to Japan.

LIST OF PARTICIPANTS IN THE JOINT COORDINATING COMMITTEE MEETING

Japanese Side

Evaluators

1) Mr. K. NAKAGAWA, Leader of the JICA Evaluation Team
2) Dr. M. KAMO, Member of the JICA Evaluation Team
3) Mr. S. SHIOYA, Member of the JICA Evaluation Team
4) Ms. R. AKEZUMI, Member of the JICA Evaluation Team
5) Mr. H. HIGASHINO, Member of the JICA Evaluation Team

JCC Members

6) Dr. J. SATO, Chief Advisor, JICA Expert Team
7) Mr. S. FURUICHI, JICA Expert Team
8) Ms. S. AKAMATSU, Coordinator, JICA Expert Team
9) Mr. S. HOSONO, Counsellor, Embassy of Japan
10) Mr. T. YAMAZAKI, First Secretary, Embassy of Japan
11) Mr. J. SASAKI, Deputy Resident Representative, JICA Malaysia Office
12) Mr. M. UEKI, Assistant Resident Representative, JICA Malaysia Office

Malaysian Side

Evaluators

1) Dr. Ibni Hajar bin Haji Rukunuddin, Director
Mechanization and Automation Research Center, MARDI

2) Assoc. Professor Dr. Abdul Razak Alimon, Department of Animal Science
Universiti Putra Malaysia

3) Dr. Vincent Ng, Director (Commodity Division),
Department of Veterinary Services

4) Y.M. Tengku Mohd. Ariff Tengku Ahmad, Deputy Director
Economy and Technology Management Research Center, MARDI

JCC Members

5) Y. Bhg. Datuk Dr. Saharan bin Haji Anang, Director General, MARDI

6) Tuan Haji Idris Abu Bakar, Industry Development,
Department of Veterinary Services

7) Mr. Abu Bakar Abdullah, Director of Agriculture
Federal Land Development Authority (FELDA)

8) Mr. Ahmad Tajuddin bin Zainuddin, Director
Economy and Technology Management Research Center, MARDI

9) Dr. Mohd. Khusahry Mohd. Yusoff, Director/Project Manager
Strategic Livestock Research Center, MARDI

10) Dr. Engku Azahan Engku Ahmad
Assistant Director/Assistant Project Manager,
Strategic Livestock Research Center, MARDI

11) Mr. Mat Daham Mat Daud, Station Management Center, MARDI

12) Dr. Mohd. Jaafar Daud, Strategic Livestock Research Center, MARDI

13) Dr. Wan Zahari Mohamed, Project Coordinator
Strategic Livestock Research Center, MARDI

14) Mr. Sarmin b. Sukir,
Economy and Technology Management Research Center, MARDI

attached document

Joint Final Evaluation Report on the Follow-up Project for Development of Technology Related to the Processing of Feed Based on Agro-Industrial By-Products of Oil Palms in Malaysia

Kuala Lumpur, December 23, 2003

Mr. Kazuo NAKAGAWA
Leader
The Japanese Evaluation Team
Japan International Cooperation Agency
(JICA)

Dr. Ibni Hajar b. Rukunudin
Leader
The Malaysian Evaluation Team
Malaysian Agricultural Research and
Development Institute
(MARDI)

CONTENTS

1. Outline of the Project

1-1. Overall Goal

The livestock industry in Malaysia is developed through the stable supply of feed based on agro-industrial by-products of oil palms.

1-2. Project Purpose

Effective, practical and viable method and system for converting by-products of oil palms into processed feed are developed.

1-3. Activities and Outputs of the Project

1-3-1.Activities (*Activities which were completed before the commencement of F/U period)

1) Improvement of feed processing system
   A. Material Supply
      a. Technology development of harvesting/collection
      b. Improvement of material handling and transportation (*)
      c. Improvement of pre-treatment methods
   B. Processing Plant (Pilot Plant)
      a. Planning and setting (*)
      b. Improvement of the processing system
      c. Evaluation of plant management
2) Improvement of feed quality
   A. Raw material analysis (*)
   B. Product analysis
   C. Improvement of nutritive values (*)
   D. Product evaluation
3) Improvement of feeding management
   A. Planning of experiments (*)
   B. Feeding experiments
   C. Improvement of feeding technology
   D. Evaluation of the feeding management system
4) Economic evaluation of OPF production
   A. Cost Analysis
   B. Comparative evaluation of feed (*)

1-3-2.Outputs

1) The methodology for processing oil palm fronds and other by-products of oil palms into processed feed is developed.

2) An appropriate method of animal feeding management on the processed feed is developed.

3) The viability of the processed feed for practical use is verified.

2. Objectives and Method of the Evaluation

2-1. Objectives of the Evaluation

The evaluation activities were performed with the purposes of:

A. Evaluating the overall achievement of the project based on the Record of Discussions (R/D), Detailed Implementation Plan (DIP), the Project Design Matrix (PDM) and Recommendations raised by the previous final evaluation committee in 2001.

B. Identifying remaining problems and recommending necessary measures to be taken after the termination of the Project to the respective governments, and

C. Considering the lessons drawn from the Project activities in order to reflect them on future projects in the interest of making them more effective and efficient.

2-2.Composition of the Joint Evaluation Committee

The evaluation was jointly conducted by both the Japanese and Malaysian members.

2-2-1.Japanese Members

1) Leader (chairperson of Joint Evaluation Committee)

Mr. Kazuo NAKAGAWA

Managing Director, Agricultural Development Cooperation Department, JICA

2) Agricultural Machinery

Dr. Mikio KAMO

Director, Department of Hilly Land Agriculture, National Agricultural Research Center for Western Region, National Agriculture and Bio-oriented Research Organization

3) Feed Production

Mr. Shigeru SHIOYA

Head, Dairy Cattle Feeding Laboratory, Department of Animal Feeding and Management, National Institute of Livestock and Grassland Science, National Agriculture and Bio-oriented Research Organization

4) Planning Evaluation

Ms. Reiko AKEZUMI

Staff, Livestock and Horticulture Division, Agricultural Development Cooperation Division, JICA

5) Evaluation and Analysis

Mr. Hideaki HIGASHINO

Consultant, RECS International Inc.

2-2-2.Malaysian Members

1) Machinery (Co-chairperson of Joint Evaluation Committee)
   Dr. Ibni Hajar b. Rukunudin
   Director, Mechanization & Automation Research Center, MARDI
2) Animal Nutrition
   Dr. Abdul Razak Alimon
   Assoc. Prof., Department of Animal Science, University Putra Malaysia
3) Animal Feeds/Livestock
   Dr. Vincent Ng
   Director, Commodity Division, Department of Veterinary Services, Ministry of Agriculture
4) Economy
   Y.M. Tengku Ariff b. Tengku Ahmad
   Deputy Director, Economic and Technology Management Research Centre, MARDI

2-3. Methods of the Evaluation

Evaluation activities were conducted by the Joint Evaluation Committee (hereinafter referred to as "the Committee"), which composed of the Japanese Evaluation Team and the Malaysian Evaluation Team in accordance with the R/D, DIP and the PDM. These activities included report analysis, field survey and discussions with concerned officials/staffs based on the five Evaluation Components listed below:

A. Relevance

Relevance refers to the validity of the Project purpose and the overall goal in connection with the development policy of the Malaysian government as well as the needs of beneficiaries.

B. Effectiveness

Effectiveness refers to the extent to which the expected benefits of the Project that have been achieved as planned and examines the benefit that was brought about as a result of the Project.

C. Efficiency

Efficiency refers to the productivity of the implementation process, examining if the input of the Project was efficiently converted into the outputs.

D. Impact

Impact refers to direct and indirect, positive and negative impacts caused by implementing the Project, including the extent to which the overall goal has been attained.

E. Sustainability

Sustainability refers to the extent to which the Project can be further developed by Malaysia, and the benefits generated by the Project can be sustained under the national policies, technology, systems, and financial state.

2-4. Schedule of the Evaluation

Date		Schedule	Japanese Eva.Team	Malaysian Eva.Team
Dec.14	(Sun)			
	17:05	Arrive at Kuala Lumpur (Mr. Higashino)		
Dec.15	(Mon)	Interview with Counterpart (Mr. Higashino)	o	
Dec.16	(Tue)	Interview with Counterpart (Mr. Higashino)	o	
	17:05	Arrive at Kuala Lumpur (Mr. Nakagawa, Dr. Kamo, Mr. Shioya, Ms. Akezumi)		
Dec.17	(Wed)			
	09:00	Courtesy Call to JICA Malaysia Office	o	
	10:20	Courtesy Call to Embassy of Japan	o	
	11:30	Courtesy Call to and Ministry of Agriculture	o	
	15:00	Courtesy Call to Deputy DG of MARDI	o	
	16:00	Discussion with JICA Experts	o	
Dec.18	(Thu)			
	09:30	Joint Evaluation Team Meeting (Explanation of Evaluation Procedure etc.)	o	o
	11:00	Visiting Oil Palm Field and the Pilot Plant	o	o
	15:00	Presentations (Review of Activities)	o	o
Dec.19	(Fri)			
	08:30	Joint Evaluation Meeting (Reviews of Activities, etc.)	o	o
	15:00	Discussion with JICA Experts and Internal Meeting	o	
Dec.20	(Sat)	Report Writing	o	
Dec.21	(Sun)	Discussion with JICA Experts and Internal Meeting	o	
Dec.22	(Mon)			
	09:30	Joint Evaluation Team Meeting	o	o
Dec.23	(Tue)			
	09:30	Preparation of Joint Coordinating Committee (Final Preparation for the Minutes of Meeting)	o	o
	14:30	Joint Coordinating Committee (Signing on Minutes of Meeting)	o	o
Dec.24	(Wed)			
	09:00	Report to JICA Malaysia Office	o	
	11:00	Report to EPU	o	
	15:00	Visiting Oil Mill	o	
Dec.25	(Thu)			
	11:05	Leave Kuala Lumpur		

3. Preparation of PDM_E (Project Design Matrix for Evaluation)

As a result of discussions, the Project Design Matrix that had been agreed at the Joint Coordinating Committee during the previous final evaluation in 2001 was updated into PDM_E, as shown in ANNEX 4, without significant changes.

On the other hand, there is an indicator in the PDM_E, which still requires more practical definition. Moreover it was difficult to obtain data on this indicator at the time of final evaluation and at the time of the project completion. Therefore, the Joint Coordination Committee agreed on the alternative given below.

3-1. Objectively verifiable indicators of the Outputs of the Project

Validity of Output 1; "The methodology for processing oil palm fronds and other by-products of oil palms into processed feed is developed" was verified by alternative indirect measures, instead of applying directly the indicator indicated in the PDM_E, "The pilot plant processes 2,000 tons of OPF feed yearly", as explained below.

(1) There are some limiting factors in the accomplishment of the pilot plant which are as follows:

- The supply of OPF raw material from UPM plantation is limited due to its small area and the distance to the pilot plant.
- The pilot plant is operated basically on experimental/research basis for performance test of the developed production technology in parallel with the OPF production. The continuous and full time operation was not possible.
- The demand of OPF feed has not reached the level at which the full operation of the pilot plant is necessary.

(2) Under these circumstances, the indicator is not applicable to judge the performance of the pilot plant.

(3) During the F/U period, because of the improvement of material collection and solar drying technology, the processing capacity of the pilot plant increased significantly and hourly production has exceeded 2 tons/hr.

(4) It is considered, therefore, that the pilot plant has the technical and potential capacity to produce the annual production indicated in PDM_E by assuming appropriate operation period (i.e. 2 tons/hour x 5 hours/day x 200 days/year = 2,000 tons /year).

4. Achievement of the Plan

Achievement of the Project plan was examined in accordance with the Accomplishment Grid (ANNEX 3) prepared by the Evaluation Team. The summary of the results is as follows.

4-1 Achievement of Inputs

4-1-1 Input from the Japanese Side

(1) Dispatch of Experts

A total of 3 long-term experts and a total of 6 short-term experts have been dispatched.

The list of the experts is attached in ANNEX 1.

(2) Provision of Equipment

List of equipment provided by Japanese side is listed in ANNEX1.

Almost all equipment is being used effectively to achieve the project purpose.

(3) Training of Malaysian Personnel in Japan

A total of 10 counterparts have visited Japan to participate in technical training. Counterpart training was well coordinated with the dispatch of short-term experts to effectively promote the transfer of technology. The list of trained personnel is attached in ANNEX 1.

(4) Supplementary Funds to Cover Local Cost

The Japanese side funded a part of the project local cost. The supplementary fund made by the Japanese side is shown in ANNEX 1.

4-1-2 Input from the Malaysian Side

(1) Assignment of counterparts

A total of 35 staff was assigned as counterparts during the Project implementation period. Among them, 5 staff were newly assigned after the commencement of the F/U period. Besides C/P staff, administration staff and drivers were also allocated for the smooth operation of the Project activities.

The list of assigned counterparts is attached in ANNEX 2.

(2) Allocation of Budget

The total amount of RM 400,000 has been allocated for operation and maintenance of the plant for 2002 and 2003. The expenditure included the repair of machineries, purchase of raw materials, fuel, packing bags and other consumables.

A part of IRPA (Intensive Research Priority Area) Project Fund was utilized for the Project activities. Items spent were on experiments, analyses, traveling costs, allowances, contract workers, repair of equipment and renting, etc. Cost for holding/attending seminars and expositions were also covered by the fund.

The list of input by Malaysian side is attached in ANNEX 2.

4-2 Achievement of Activities

Attainment of Activities by DIP is attached in ANNEX 3.

4-2-1. Material Supply and Solar Drying System

Before F/U period, the small or medium size machinery system was developed and operated mainly by manual. As such, the system did not meet the production capacity required. During the F/U period, an integrated machinery system was developed. The development of the OPF harvester

has enabled the smooth operation of whole process of collection, chipping, loading and unloading of OPF in the oil palm plantations. The working capacity of the OPF harvester is almost equivalent to that of 30 manual workers. This system satisfies the requirement for large-scale production of a pilot plant.

In terms of solar drying system, during the F/U period, a new solar drying green house equipped with 45 degree inclined fans and agitators, was successfully developed. It has almost 5 to 10 times drying capacity as compared to the original green house. These modifications have significantly reduced the cost of the artificial drying.

(2)Processing Plant (Pilot Plant)

During the F/U period, plans for improving the existing pilot plant machinery that were suitable for OPF were studied and the required renovation and modification were implemented. A stable and continuous production of OPF feed was realized by renovating and modifying many parts of pilot plant machinery. Besides the renovation of processing line, plant management including safety control, maintenance, and quality control were improved through management technique such as "5S(Seiri or sort out/Seiton or arrange/Seiso or cleaning/Seiketsu or hygiene/ Sitsuke or discipline)" or "KAIZEN(Improvement)" method.

The initial moisture content of the artificial drying was found to be affected by the weather conditions. Therefore, an artificial drying technology, which would not be affected by the initial moisture content, should be developed within the remaining F/U period.

(3) Improvement of Feed quality

All the items were completed during the F/U period as scheduled.

Lead (Pb) concentration in OPF feed was analyzed by ICP-MS and found to be within Japanese safety level (3 mg/kg).

Optimum mixing ratio of OPF Total Mixture (TM) feed for each beef cattle and milk cow was determined to be 30%.

A quality check manual for OPF products was published to establish consistent quality production technology.

(4) Improvement of Feeding Management

All the items will be completed during the F/U period as scheduled.

The result of feeding experiment at institutional and private farms showed that OPF-TM cube is nutritionally balanced and suitable for both dairy and beef cattle production.

Results of the feeding trials, OPF-TM cube feed vs. conventional feedings are as follows:

1) For dairy cow, there was no significant difference in milk yield and composition, but OPF-TM

cube is advantageous in saving labor work (feeding work).

2) For beef cattle, the ADG (average daily gain) was 0.93 kg/day for cattle fed with OPF-TM cube as compared to 0.24 kg/day for cattle fed with wheat, PKC, and cut grass.

3) The reduction of growth period from 500 days to 129 days (body weight: from 200 kg to 320 kg).

4) Increase the carcass weight from 107 kg to 109kg with increase of rib-eye area from 7.4cm^2 to 8.1 cm^2.

In order to make the feeding management manual to be widely used in Malaysia, field experiment should be conducted under various regional conditions and feeding mode.

(5) Economic Evaluation

Analyses of the components cost of production of OPF feed were undertaken. Based on the findings, modifications in the system were carried out to further reduce costs and increase efficiency of the pilot plant. A simulated livestock model management with OPF-TM-Cube was also established. (Please refer to item 4-3, Output 3)

4-3. Achievement of Outputs

Achievement of Outputs was found to be satisfactory for the F/U period.

Output 1: The methodology for processing oil palm fronds and other by-products of oil palms into processed feed was developed.

Indicator (1): The pilot plant processes 2,000 tons of OPF feed yearly.

Assessment on the capacity of the plant indicated that the pilot plant has a technical and potential capability of producing 2,000 ton/year (assuming that 2 tons/hr x 5 hr/day x 200 days/yr = 2,000 tons/yr). However, there were limiting factors that constrained the accomplishment of the targeted Output. They were i) limited supply of OPF raw material from UPM plantation, ii) pilot plant was operated basically on experimental/research basis for performance test of the production technology and was not operated continuously, and iii) the demand of OPF feed was not sufficient to produce the quantity that could be potentially generated by the plant. During the F/U period, the improvement of the material collection and solar drying technology had increased significantly the processing capacity of the pilot plant and the hourly production rate has exceeded 2 tons/hr. As a result, it was estimated that the pilot plant has a potential of producing 2,000 tons/year.

Indicator (2): Comparable quality to conventional fibrous feed product.

The lead (Pb) content was found to be less than 3 ppm (below the safety level required by Japanese standard) by ICP-MS measurement.

Output 2: An appropriate method of animal feeding management on the processed feed is developed.

Indicator (3): OPF feeding standardization for beef and dairy cattle.

(1) Beef cattle; OPF-TM-Cube was tried at large scale farms such as in oil palm plantation companies and the result showed that weight increase was almost twice that of the controlled feed.

(2) Dairy cow; experiments were conducted at small farms. Results showed that OPF-TM-Cube that involved mixing of OPF and other by-products to produce well balanced feeds, had shown some advantages in increasing milk yield.

(3)Feeding management manual for beef and dairy cattle with OPF based feeds was developed based on experimental data.

Output 3: The viability of the processed feed for practical use is verified.

Indicator: Market Competitiveness

A simulation carried out based on the potential output of the pilot plant showed that the production cost of 100% OPF was estimated to be RM157 per ton (cube production efficiency at 30 tons/day) while the cost for OPF-TM cube was RM414 (cube production efficiency at 30 tons/day). This was lower than the market price of most other feedstuffs such as rice bran, hay and wheat pollard in Malaysia.

4-4. Achievement of Project Purpose

Project Purpose achievement was acceptable during the F/U period.

It can be concluded that the Project purpose has been accomplished satisfactorily during the F/U period. Through the improvement of each component of the package technology, i.e., material supply, drying, plant processing, and animal feeding, the quality of the OPF based feed has been found to be more consistent. Although the technology has not been fully promoted or disseminated to end users, it has already drawn attention from relevant statutory bodies. User's confidence was partially verified based on the field experiment, although continuation of the field experiment/survey and accumulation of data is still necessary for future dissemination of the technology.

4-5. Prospect for Achievement of Overall Goal

The Overall Goal, as originally set during the Project planning, is considered difficult to be achieved within the Project time frame and scope. There is a big gap between the Project purpose and the Overall Goal. Therefore, in the long-term, various supporting activities and coordination among the related governmental organizations will be necessary to achieve the Overall Goal.

Specifically, in order to make progress towards the Overall Goal, it is necessary that measures for disseminating the developed technology be undertaken by MARDI in coordination with other related governmental organizations. The incubator system, which is now under planning for implementation, will be a prime force for technology dissemination by MARDI. The prospects for sustainability would be higher if the incubator system is successfully implemented.

5. RESULTS OF THE EVALUATION

5-1.Relevance

Relevance of the Project implementation is High.

The Project Purpose and the Overall Goal of the Project have a high degree of consistency to the national agricultural policy of Malaysia and the needs of the society.

In Malaysia, 75% of beef, and 95% of milk or related products are imported. The Malaysian government is planning to raise self-sufficiency level by doubling the domestic production by 2010. On the other hand, ruminants such as cattle need to be fed with pasture or feed crop containing high fiber. However, high land opportunity cost prevents the cultivation of pasture crops. This shortage of supply of high quality raw materials for feeds will affect the overall production of livestock. Thus, utilization of OPF into animal feeds will support the increase of livestock and dairy production and is consistent with the Malaysian policy and also the needs of livestock farmers.

However, the project has not shown much direct and visible contribution or significance to the local population at the moment. Nevertheless, the Project is trying to exploit the use of OPF to increase local feed supply, which can subsequently contribute to increase the self-sufficiency of beef and milk, etc. Therefore, it is considered that the Project has high relevance to the needs of Malaysia.

The Project also has contributed greatly to the transfer of knowledge to the C/P personnel of MARDI through the OJT (On-the-Job Training) and training in Japan.

5-2.Effectiveness

The effectiveness of the Project during the F/U period is High.

In the F/U period, almost all activities carried over from 5-year project were undertaken and the remaining issues were dealt with efficiently. The remaining issues include improvement of the drying system by solar energy, improvement of OPF pilot plant and introduction of new plant management technique.

As a result of the renovation, stable production OPF feed production was achieved through a "package technology" and the pilot plant has a sufficient technical and potential capacity to meet the targeted demand of the OPF production. In addition, through the "5S" and "KAIZEN" activities, the pilot plant staff has learned the basics of quality control and management skills.

Feeding experiments on OPF feeds were conducted at institutional farms and selected private farms. As a result, practical feeding technique was developed.

Presentations, publications, and expositions in related fields were made and had attracted a lot of attention from both the public and private sectors.

5-3.Efficiency

Efficiency of the Project during the F/U period is High.

During the F/U period, inputs required were delivered mostly on time by both sides, and substantial improvement was made in various technical aspects. On the Japanese side, there was an absence of a Coordinator for three months from June 2003 to September 2003. However, the long-term experts and C/P staff managed to implement the Project activities by assisting each other. The budget for the OPF harvester development and the modification work of the solar drying facilities was allocated in the final year of the 5-year project, contributing to the prompt technology improvement on the two fields at the beginning of F/U.

5-4.Impact

Positive impact to the implementing agency is observed.

1) The Overall Goal, as originally set during the Project planning, is considered difficult to be achieved within the Project time frame and scope. Therefore in the long term, various supporting activities, and coordination among the related governmental organizations are necessary to achieve the Overall Goal.

2) By developing the technology to handle OPF as a new source of raw material for animal feed, various scientific findings and engineering technologies were successfully generated. Based on the findings and the technology development, more than 30 publications or papers related to the Project were documented. These facts reinforced the confidence of MARDI on the OPF product. As a result, MARDI has decided to initiate the "incubator system" for transfer of technology to the industry. extend the technology by themselves.

3) Based on the findings and technologies developed, application for three patents have been submitted by MARDI to SIRIM (Standards and Industry Research Institute, Malaysia) in

collaboration with JICA. Intellectual property which will be obtained through the Project activity is expected to enhance the financial standing of MARDI in the future.

The staff of the pilot plant has also acquired plant management skills including safety control, maintenance, and quality control through "5S" and "KAIZEN" activities in addition to the technology transfer. This has improved the mutual understanding among staff and has greatly contributed to the collaborative efforts in the pilot plant.

5-5.Sustainabilty

It is considered that the Project is sustainable in the long term.

1) MARDI is an outstanding research institution in Malaysia with approximately 2,800 staff. The counterpart staff assigned to the Project are capable and gained a lot of experiences through the Project implementation. Therefore, it is considered that MARDI has sufficient capability to continue the Project activities independently after the termination of the cooperation period. However, the following aspects are considered important for the sustainability of the Project:

2) Although financial allocation of MARDI for operational costs has satisfactorily contributed to the progress of the Project activities, but in order to maintain the production of OPF feeds in the pilot plant, the amount of cost required will be high for material supply, transportation and operation. For the management of the pilot plant, institutional support for budget as well as management is required.

3) Extension/dissemination of the technology and the production of OPF feeds by private sectors through incubator system are crucial to sustain the positive effect of the Project. Recently, the inquiry from oil palm plantations has been increasing. However, detailed plan of the incubator system has yet to be developed. It seems that a bit more time is required before this technology could be introduced and transferred to private sectors through MARDI.

6. Conclusion

Based on the series of discussions with relevant officials and counterparts as well as field survey, the Committee observed that the recommendations raised by the previous final evaluation committee in 2001 were tackled actively in cooperation with Japanese experts and Malaysian counterparts. Although there are some activities yet to be achieved for the remaining F/U period, the Committee recognized that the Project could achieve the outputs and project purpose as set by R/D. The remaining activities are within the competencies of the trained counterparts who have the experience and know-how obtained through the Project period. The activities should therefore be

continued even after the termination of technical cooperation with JICA to ensure the success of the Project purpose by the Malaysian side. Therefore, the Committee concludes that the Project be terminated on March 14, 2004 as planned in the R/D.

7. Recommendations

To sustain and further develop the achievement of the Project, the Committee recommends the following.

(1) Project Team should fully utilize the last three months to accomplish the remaining task and prepare the termination of the Project.

(2) The Committee strongly expects that MARDI/Malaysian government should provide the leadership and commitment for the dissemination of the technologies developed through the Project. To disseminate the achievement of the Project, it is essential for MARDI to make best efforts independently including the implementation of the "incubator system" and promote the technology to the local clients through collaboration with related institutions of the Ministry of Agriculture, Ministry of Primary Industry and Ministry of Finance.

(3) The Committee expects that the final seminar scheduled on February 17, 2004 would be the best opportunity to carry out public awareness and promotion in relation to the achievement of the Project and to formulate methods for technology dissemination to interested parties.

(4) MARDI should take necessary measures to acquire the patents as soon as possible which are in the process of application to SIRIM with close consultation with JICA. Likewise should other countries request these patented technologies from JICA, JICA would do so in close consultation with MARDI before transferring them.

(5) MARDI should continue to conduct feeding experiments during and after the Project and increase the number of field trials. The Committee recognized that it is important to gain the reliability of data so that the benefits of the technology can be easily understood by the interested parties.

(6) To use the pilot plant effectively after the Project period, it is essential to prepare the maintenance system including allocation of budget and assignment of necessary staff and additional workers at the operation level.

(7) To develop the livestock industry in Malaysia, MARDI should consider the possibility to make the best use of the individual technology components generated from the Project. For example, it is conceivable that the chipped OPF could be fed directly to livestock without further processing.

8. Lessons learned from the Project

(1) "5S" and "KAIZEN" introduced actively by Japanese experts during the Project impressed the plant management skills of the pilot plant staff. This has improved the mutual understanding among staff and has greatly contributed to the collaborative efforts in the pilot plant.

(2) Cooperation within MARDI has greatly contributed to the achievement of the Project Purposes. For example, the comments from the section on feeding experiment were appropriately incorporated in the processing of OPF-TM cubes in the pilot plant.

(3) Although the Project Purpose has been satisfactory achieved, the Overall Goal, as originally set during the Project planning, is considered difficult to be achieved within the Project time frame and scope. A realistic goal should have been formulated for future direction of the Project. Careful examination and deliberation among the project stakeholders, planners and implementers are required during the initial stage of project formulation.

Annex 1 Imputs by Japanese Side

I-1.Experts

[F/U period]

Long Term Experts

Name	Duration			Subject	Organization
JUNICHI SATO	2001/4/1	-	2004/3/14	Chief Adviser/ Feeding Management	Ministry of Agriculture, Forestry and Fisheries
HIDEKAZU TANAKA	2002/3/3	-	2003/6/11	Project Coordinator	CDC International Corporation
SHINGO FURUICHI	2002/3/15	-	2004/3/14	Agricultural Machinery	IC Net Limited

Short term Experts

Name	Duration			Subject	Organization
AKINORI OSHIBE	2002/8/18	-	2002/9/14	Evaluation of Feeding Management	Japan International Research Center for Agricultural Sciences
AKIRA KAWASAKI	2002/9/11	-	2002/10/9	Toxicological Analysis and Product safety	National Institute for Agro-Environmental Sciences
KIMINORI NOGUCHI	2003/2/2	-	2003/2/28	Plant Machinery	Daiichi Sangyo Inc.
HIROKI UKAWA	2003/9/1	-	2003/9/26	Simulation of Livestock Farming Model (using OPF based complete cubes)	National Agricultural Research Organization
SHIHO AKAMATSU	2003/9/1	-	2004/3/14	Project Coordinator	TAC International Inc.
AKINORI OSHIBE	2003/11/3	-	2003/11/15	Livestock Management	National Agricultural Research Organization

[5- Year Project]

Long term Experts

Name	Duration			Subject	Organization
KOICHI TANAKA	1997/3/15	-	2002/3/14	Agricultural Machinery	Ministry of Agriculture, Forestry and Fisheries
SHUICHI OSHIO	1997/3/22	-	1999/3/21	Feed Evaluation	Ministry of Agriculture, Forestry and Fisheries
SHOJI NISHIKAWA	1997/4/10	-	1999/4/9	Project Coordinator	
HIROFUMI HAYAKAWA	1997/4/10	-	2001/4/9	Chief Adviser/Feeding Management	Japan International Research Center for Agricultural Sciences
AKIRA NISHIKORI	1999/3/1	-	2002/3/14	Project Coordinator	Japan Overseas Cooperation Association
AKINORI OSHIBE	1999/3/15	-	2002/3/14	Feed Evaluation	Ministry of Agriculture, Forestry and Fisheries
JUNICHI SATO	2001/4/1	-	2004/3/14	Chief Adviser/Feeding Management	Ministry of Agriculture, Forestry and Fisheries

Short term Experts

Name	Duration			Subject	Organization
SOUICHI TAKAI	1997/7/7	-	1997/8/10	Consultation/Agricultural Processing Machinery and Processing Plant	Intem Consulting Inc.
NOBORU ANDO	1997/7/7	-	1997/8/10	Consultation/Agricultural Processing Machinery and Processing Plant	Intem Consulting Inc.
HIROKI UKAWA	1997/9/4	-	1997/10/2	Economic Analysis	Hokkaido National Agricultural Experiment Station
KATSUHIKO TAMAKI	1998/2/10	-	1998/3/23	Agricultural Processing Machinery	National Grassland Research Institute
KAZUHISA NONAKA	1998/2/10	-	1998/3/23	Feed Analysis	Hokkaido National Agricultural Experiment Station
SOICHI TAKAI	1998/5/16	-	1998/5/27	Plant and Machinery Installation	Intem Consulting Inc.
SHIGEHIKO MASAKI	1998/6/18	-	1998/7/16	Evaluation of the Deterioration in the Chemical Components of Oil Palm Fronds	National Institute of Animal Industry
SOICHI TAKAI	1998/7/27	-	1998/8/16	Plant and Machinery Installation	Intem Consulting Inc.
HIDENORI KAWAMOTO	1998/10/19	-	1998/12/13	Presumption Method of voluntary Intake for OPF	National Grassland Research Institute
KAZUTOMO ICHITO	1999/3/20	-	1999/4/19	Improvement of Harvest / Collection Technology based on OPF	National Grassland Research Institute
SANAE HASHIMOTO	1999/3/28	-	2000/2/27	Feed Processing Machinery and Feed Processing Technique	
TAKAYUKI KOJIMA	1999/5/9	-	1999/5/14	Preparation of specifications and Tender document for Cubic machine	Intem Consulting, Inc.
TAKAYUKI KOJIMA	1999/7/27	-	1999/8/16	Assistance of Tender	Intem Consulting, Inc.

Name	Duration			Subject	Organization
AKIRA WATANABE	1999/8/28	-	1999/9/6	Chechiking Method of meet Quality and Blood Characteristic for Beef Cattle	Tohoku National Agricultural Experiment Station
NAONOBU UMEDA	1999/11/5	-	1999/12/3	Improvement of Pre-treatment Technology Based on OPF	National Grassland Research Institute
YUKINORI SHIBUYA	2000/2/11	-	2000/3/19	Mechanization Technology of Harvesting-Collection	Tohoku National Agricultural Experiment Station
HIROKI UKAWA	2000/3/22	-	2000/4/18	Economic Evaluation and Cost Analysis	Hokkaido National Agricultural Experiment Station
SANAE HASHIMOTO	2000/4/17	-	2000/10/15	Plant Production Control Technology	
TETSUHISA GOTO	2000/9/30	-	2000/10/28	Toxicological Analysis and Product Safety	National Food Research Institute
WATARU IIJIMA	2000/9/30	-	2000/10/28	Automation Mechanize OPF Collection by Using Grabber	National Grassland Research Institute
YUJI SHIRAI	2001/6/19	-	2001/7/16	Analysis of Agro-Chemical Residues in OPF	National Fertilizer and Feed Inspection Station
MASAHIRO AMARI	2001/6/30	-	2001/7/27	Application Technology of NIR Analysis	National Institute of Livestock and Grassland Science
KIMINORI NOGUCHI	2001/10/14	-	2001/11/8	Feed Processing Plant Machinery	Daiichi Sangyo Inc.
HIROKI UKAWA	2001/10/30	-	2001/11/29	Cost analysis of OPF Feed Production	National Agricultural Research Center for Hokkaido region
SHINGO FURUICHI	2001/11/29	-	2002/1/25	Improvement of Solar Drying	Japan International Cooperation Center

Annex 1

I-2 C/P training in Japan

[F/U Period]

Name	Training Period	Training Subject	Main Training Organization	Department	Position	Current Position/ Transferred Organization
Mohamed Khusahry bin Dr. Mohamed Yusuf	2002/3/30 - 2002/4/12	Evaluation on Feeding Management	TIC	Strategic Livestock Research Centre	Director	
Engku Azahan Bin Dr. ENGKU AHMED	2002/7/10 - 2002/7/30	Feeding Management and Strategies for Improved Production of Livestock	NILGS	Strategic Livestock Research Centre	Deputy Director	
Mr. Mohd Safidin KASHIM	2002/7/14 - 2002/8/16	Quality Control in Heavy Metals analysis in OPF samples	NIAES	Technical Service Centre	Research Officer	
Mr. SAMSUDIN Bin Ahmad	2002/8/16 - 2002/9/14	Mechanization and Drying Technology	NILGS	Mechanization & Automation Research Centre	Senior Research Officer	
Mr. Md. Mohd Akhir Hamid	2002/8/16 - 2002/9/14	Agriculture Mechanization	NILGS	Mechanization & Automation Research Centre	Senior Research Officer	
Mr. Kamaldine Bin Hassan	2002/10/1 - 2002/10/31	Livestock Management	NARC(Tohoku)	Strategic Livestock Research Centre	Technician	
Mr. Mohd Yunus Ismail	2002/10/12 - 2002/10/26	Plant Machinery Operation and Management	Daiichi Sangyo Inc.	Strategic Livestock Research Centre	Senior Research Officer	
Mr. Rubbuan Said	2002/10/12 - 2002/10/26	Plant Machinery Operation and Management	Daiichi Sangyo Inc.	Strategic Livestock Research Centre	Research Assistant	
Wan Abdul Ghani Bin Mr. Mohamed	2002/10/12 - 2002/10/26	Plant Machinery Operation and Management	Daiichi Sangyo Inc.	Strategic Livestock Research Centre	Research Assistant	
Mr. Jumaat Awi	2002/10/12 - 2002/10/26	Plant Machinery Operation and Management	Daiichi Sangyo Inc.	Strategic Livestock Research Centre	Research Assistant	

TIC:Tokyo International Centre JICA, NILGS: National Institute of Livestock and Grassland Science, NARC: National Agriculture Research Center
NIAES: National Institute for Agro-Environmental Science, NAES: National Agricultral Experiment Station,
JIRCAS: Japan International Research Center for Agricultural Sciences, NIAI: National Institute of Animal Industry
NGRI: National Grassland Research Institute, NFRI: National Food Research Institute, NFFIS: National Fertilizer and Feed Inspection Station

[5-Year Project]

Name	Training Period	Training Subject	Main Training Organization	Department	Position	Current Position/ Transferred Organization
Siti Badariah Bt Ms. Saiful NATHAN	1997/10/6 - 1997/12/13	Economy Evaluation	JIRCAS, NAES(Hokkaido)	Economic and Technology Management Reesearch Center	Senior Researcher	University of Putra Malaysia
Ms. Rosnizah Bt ISMAIL	1997/10/6 - 1997/12/13	Feed Fiber Analysis	NIAI	Livestock Research Centre	Research Assistant	
Mr. Mat Daham Mhod DAUD	1997/10/12 - 1997/11/14	Plant Planning	Private Companies	Livestock Research Centre	Senior Researcher	
Mr. Hamdan Bin AB MANAP	1997/10/12 - 1997/11/14	Material Supply	Private Companies	Strategic Environment & Natural Resources	Senior Researcher	
Ms. Sarah Bte RASOL	1998/2/23 - 1998/4/24	Sugars and Organic Acids Analysis	NIAI	Livestock Research Centre	Research Assistant	
Mohamed Ariff Bin Dr. OMAR	1997/3/30 - 1997/4/10	Project Management	TIC	Livestock Research Centre	Director	Director of Station Management centre, MARDI
Dr. Wan Zahari MOHAMED	1998/5/11 - 1998/7/11	Feeding Management	NIAI, Univ. Kyoto	Livestock Research Centre	Assistant Diirector	
Mr. Idris Bin MOHAMED	1998/8/31 - 1998/9/30	Safety and Environment Management of Plant	Private Companies	Coporate Management Services	Assistant Director	
Mr. Mohd Yunus ISMAIL	1998/8/31 - 1998/10/30	Plant Management	NGRI	Livestock Research Centre	Assitant Research officer	
Mr. Rubbuan SAID	1998/10/26 - 1998/12/25	Machinery Operation and Maintenance	NAES (Kyushu)	Livestock Research Centre	Research Assistant	
Dr. Abu Bakar Bin CHIK	1999/6/2 - 1999/8/3	Nutrition Management of Dairy Cattle	NGRI	Livestock Research Centre	Senior Research Officer	
Mohd. Sukri Bin HJ Mr. IDRIS	1999/6/2 - 1999/8/3	Nutrition Management of Beef Cattle	NAES (Tohoku)	Livestock Research Centre	Senior Research Officer	

TIC: Tokyo International Centre JICA, NILGS: National Institute of Livestock and Grassland Science, NARC: National Agriculture Research Center
NIAES: National Institute for Agro-Environmental Science, NAES: National Agricultral Experiment Station,
JIRCAS: Japan International Research Center for Agricultural Sciences, NIAI: National Institute of Animal Industry
NGRI: National Grassland Research Institute, NFRI: National Food Research Institute, NFFIS: National Fertilizer and Feed Inspection Station

Name	Training Period	Training Subject	Main Training Organization	Department	Position	Current Position/ Transferred Organization
Mr. Wan Abdul Ghani Bin MOHAMED	1999/8/1 - 1999/10/2	Material Drying of Oil Palm Fronds	NGRI	Livestock Research Centre	Research Assistant	
Mr. Abdul Rahman Bin ABDULLAH	1999/8/1 - 1999/10/2	Material Supply and Handling	NGRI	Strategic Environment & Natural Resources	Research Assistant	
Dr. Mohamad Jaafar Bin DAUD	1999/10/3 - 1999/11/30	Simple Estimation of Indigestible Components	NGRI	Livestock Research Centre	Senior Research Officer	
Ms. Marini AHMAD MARZUKI	2000/8/28 - 2000/9/28	Toxicity Analysis and Product Safety	NFRI	Livestock Research Centre	Research Officer	
Mr. Mohd. Shrudin MOHD. ALI	2000/9/3 - 2000/10/28	Feed quality management for processing	NGRI	Livestock Research Center	Assistant Researcher	
Mr. Hussin B. MAT SAAN	2000/9/3 - 2000/10/28	Feed processing managiment	NGRI	Livestock Research Centre	Senior Assistant Researcher	
Mr. Mohd Shukri bin Abdullah	2000/9/25 - 2000/11/25	Dairy Cattle Management	NGRI	Department of Veterinary Services	Veterinary staff	
Mr. Wan Razali B. OMAR	2000/9/25 - 2000/11/25	Animal Feeding Management	NGRI	Livestock Research Centre	Assistant Researcher	
Ms. Faridah SALAM	2001/5/7 - 2001/6/12	Chemical analysis for feed safety	NFFIS	Livestock Research Centre	Research Officer	
Mr. Zainal Abidin ABDUL RAHMAN	2001/5/7 - 2001/6/12	Application Technology of NIR Analysis	NILGS	Livestock Research Centre	Research Assistant	
Mr. Zainal Abidin Bin ZULKAFLI	2001/9/27 - 2001/10/26	Material drying of oil palm fronds	NILGS	Livestock Research Centre	Research Assistant	

TIC: Tokyo International Centre JICA, NILGS: National Institute of Livestock and Grassland Science, NARC: National Agriculture Research Center
NIAES: National Institute for Agro-Environmental Science, NAES: National Agricultral Experiment Station,
JIRCAS: Japan International Research Center for Agricultural Sciences, NIAI: National Institute of Animal Industry
NGRI: National Grassland Research Institute, NFRI: National Food Research Institute, NFFIS: National Fertilizer and Feed Inspection Station

I-3 Provision of Equipment

Annex 1

Equipment based on A4 form (F/U)

JP Fiscal Year	Equipment/Material	Maker	Model	Q'ty	Unit Price(RM)	Amount (RM)	Unit Price(JPY)	Amount (JPY)	Place	Usage	Manage ment	Currennt Situation
2001	Fan system for Solar dryer		Panel Fan Model LBP36 6units	1	17,700.00	17,700.00			Plant	A	A	O
2001	Blower	Kawahara Engineering		12	2,733	32,800			Plant	A	A	O
2001	Forrage puddle driving machine	Lab.N.Industries		1	58,000	58,000			Plant	A	A	O
2001	OPF Mixer (modification)	Kawahara Engineering	Modified	2	78,000	156,000			Plant	A	A	O
2002	Forage Harvester	New Holland	TM125SP	1			18,400,000	18,400,000	Plant	A	A	O
2002	Mixer/Mill and accessories	Spex	8000M-230	1	27,440				TSC	A	A	O

Equipment based on A4 form (5 years)

JP Fiscal Year	Equipment/Material	Maker	Model	Q`ty	Unit Price(RM)	Amount (RM)	Unit Price(JPY)	Amount (JPY)	Place	Usage	Managem ent	Currennt Situation	Remarks
1997	Desk Top PC	Vision	200 MPC With MMX Tech.	1	5,790.00	5,790.00			Plant	B	B	O	
1997	Desk Top PC	Vision	Pentium 166 MPC	1	3,550.00	3,550.00							Broken・ Discarded
1997	Desk Top PC	Vision	Pentium 200 MPC	1	5,580.00	5,580.00			Plant	B	B	O	
1997	Desk Top PC	Vision	Pentium 200 MPC	1	5,580.00	5,580.00			Plant	B	B	O	
1997	Desk Top PC	Vision	Pentium 200 MPC	1	5,580.00	5,580.00			Plant	B	B	O	
1997	Desk Top PC	Vision	Pentium 166 MPC	1	4,750.00	4,750.00			PKC	B	B	O	
1997	Desk Top PC	Vision	Pentium 166 MPC	1	4,750.00	4,750.00							Broken・ Discarded
1997	Gas Chromatograph	SHIMADZU	GC-17AAF	1	106,552.00	106,552.00			SLRC 1F	C	A	O	
1997	Copier	MINOLTA	EP5000	1	19,950.00	19,950.00			SLRC 3F	A	A	O	
1997	Incubator	SHAKER	TA-25RS	1	80,267.35	80,267.35			SLRC 1F	E			Repair
1997	4WD Vehicle	Mitsubishi	Pajero	1	74,137.01	74,137.01			SLRC GF	A	A	O	
1997	4WD Vehicle	Mitsubishi	Pajero	1	74,137.01	74,137.01			SLRC GF	A	A	O	
1997	Handphone	Motorola	Star Tac 90	1	2,880.00	2,880.00							Broken・ Discarded
1997	LCD OHP Projector	AVIO	MP-200	1	26,500.00	26,500.00			SLRC GF	A	A	O	
1997	Digital Camera	Sony	MCV-FD7	1	3,100.00	3,100.00			Plant	A	A		

JP Fiscal Year	Equipment/Material	Maker	Model	Q`ty	Unit Price(RM)	Amount (RM)	Unit Price(JPY)	Amount (JPY)	Place	Usage	Managem ent	Currennt Situation	Remarks
1997	Plotter	HP	Jet350c Model E	1	16,430.00	16,430.00			SLRC 3F	C	A	o	
1997	Scanner	UMAX	Astra1200S	1	3,850.00	3,850.00			SLRC 3F	C	A	o	
1997	Electric Blower/Heater(for solar dryer)		Dia.28" Airflow rating 8850CFN	1	60,000.00	60,000.00			Plant	-	-		Modified
1997	Tracked in-field-transporter	Yanmar	F37ex with trailer	1	74,410.00	74,410.00			Plant	B	A	o	
1997	Tracked in-field-transporter	Yanmar	F37ex with trailer	1	74,410.00	74,410.00			Plant	B	A	o	
1997	Truck 3t	Mitsubishi	FE639E	1	66,869.04	66,869.04			Plant	A	A	o	
1997	Truck 1t	Mitsubishi	FB511B	1	49,335.20	49,335.20			Plant	A	A	o	
1997	Chopper With engin	Otofin	MFH2520	1	88,000.00	88,000.00			Plant	-	A		Dismantling
1997	Chopper With engin	Otofin	MFC2310	1	34,550.00	34,550.00			Plant	C	A	o	
1997	Solar Dryer set	OKADA etc.	D300-6 etc.	1	505,000.00	505,000.00			Plant	A	A	o	
1997	Particle size measurement	Retsch	AS200	1	13,629.00	13,629.00			Plant	C	A	o	
1997	Feed Grinder	UDY	UDY3010-019	1	11,979.00	11,979.00			LRC 1 F	C	B	o	

JP Fiscal Year	Equipment/Material	Maker	Model	Q`ty	Unit Price(RM)	Amount (RM)	Unit Price(JPY)	Amount (JPY)	Place	Usage	Managem ent	Currennt Situation	Remarks
1997	Chest Freezer	ACSON	ACF560	1	2,306.00	2,306.00			PKC LAB	A	B	o	
1997	Refrigerator	National	NR-C36F1H	1	4,610.00	4,610.00			PKC LAB	A	B	o	
1997	Analytical Balance	A&D	HR200	1	5,138.25	5,138.25			PKC LAB	A	A	o	
1997	Top-Pan Balance	A&D	HF3000G	1	3,557.25	3,557.25			Plant	C	A	o	
1997	Platform Scale	A&D	HW100KA1	1	3,585.71	3,585.71			Plant	C	A	o	
1997	Animal weighing machine	A&D	LC5223-K500 AD4322MKII	1	11,710.36	11,710.36			SLRC 1F	E			Repair
1998	Fibertec System	Tecator	F-M6	1	66,500.00	66,500.00			PKC LAB	C	A	o	
1998	Pelletising Line machinery (Feed Plant)			1	3,780,000.00	3,780,000.00			Plant	A	A	o	
1999	Cuber Line machnery (Feed Plant)			1	1,720,000.00	1,720,000.00			Plant	A	A	o	
1999	Chopper	Otofin	MFH2530	1	64,910.00	64,910.00			Plant	A	A	o	
1999	Biosafety Cabinet	Nuaire	NU425-600E	1	29,000.00	29,000.00			PKC LAB	A	A	o	
1999	Forklift with Bucket	Nissan	WGF03H45U-2W400	1	132,800.00	132,800.00			Plant	A	A	o	

JP Fiscal Year	Equipment/Material	Maker	Model	Q`ty	Unit Price(RM)	Amount (RM)	Unit Price(JPY)	Amount (JPY)	Place	Usage	Managem ent	Currennt Situation	Remarks
1999	Slow speed agitator for B2 bin			1	29,500.00	29,500.00			Plant	A	A	O	
1999	Mechanical slide track for sewing machine			1	19,030.00	19,030.00			Plant	C	A	O	
2000	Acrylic material for Solar House Roof		Malpex/Polylex Hi-Impact(HI-PMMA) Corrugated	7700 sq.ft	8.40	64,680.00			Plant	A	A	O	
2000	Solar Dryer Unit Cabin		Size 20ft x 8ft x 8ft10in	1	14,200.00	14,200.00			Plant	A	A	O	
2000	Data taking & control system for solar house		Supplier: Innovative Industrial Computing	1	35,860.00	35,860.00			Plant	C	A	O	
2000	Shredder		Mighty MAC SC 182 with conveyor belt	1	43,500.00	43,500.00			Plant	A	A	O	
2000	Exhaust Fan		Axial flow fan 30"	6	4,100.00	24,600.00			Plant	A	A	O	
2000	Mobile conveyor belt		10m	2	24,750.00	49,500.00			Plant				Broken・ Discarded Modified
2000	Material conveying system for S1			1	85,000.00	85,000.00			Plant	A	A	O	
2000	Service platform for A7			1	9,800.00	9,800.00			Plant	A	A	O	
2000	Service platform for B1&B2			1	18,000.00	18,000.00			Plant	A	A	O	
2000	Service platform for D1			1	10,500.00	10,500.00			Plant	A	A	O	

JP Fiscal Year	Equipment/Material	Maker	Model	Q`ty	Unit Price(RM)	Amount (RM)	Unit Price(JPY)	Amount (JPY)	Place	Usage	Managem ent	Currennt Situation	Remarks
2000	Service platform for G1			1	10,500.00	10,500.00			Plant	A	A	o	
2000	Dust cover for A7&B1			1	13,500.00	13,500.00			Plant	A	A	o	
2000	Vibration absorber for A5			1	4,500.00	4,500.00			Plant				Modified
2000	Alarm buzzer for boiler			1	8,500.00	8,500.00			Plant	A	A	o	
2000	Steel bridge			1	23,000.00	23,000.00			Plant	A	A	o	
2000	Hot air generator system for solar house		Diesel burner: Benton B20	2	37,000.00	74,000.00			Plant	C	A	o	
2000	Diagnostic Ultrasound System , Paper and Gel	ALOKA	Probe:UST-5818-5, Cart:RTM900, Printer:UP-895MD	1			3,800,000.00	3,800,000.00	Kluang	C	A	o	
2000	Centrifuge	KUBOTA	KA-100A and Glass tube(15ml/10pcs),Tub e rubber sole,fuse	1			189,700.00	189,700.00	SLRC 1 F	A	A	o	
2000	Solar Radiation monitoring system		Logger, KDC-S11-03E, KDC-S11-AM ARM,Pole with stand,	1			498,800.00	498,800.00	Plant	C	A	o	
2000	Hardness tester	IMADA	40,DP1HS with transformer,CB-301cable,HV-100W	1			314,250.00	314,250.00	Plant	C	A	o	
2000	Digital Tachometer	ONO SEKKI	HT-5100,PB-703 with transformer, HT-011(10sheets/set)	1			81,250.00	81,250.00	Plant	C	A	o	
2000	High pressure Water Washer	BANZAI	CW-7-50	1			684,000.00	684,000.00	Plant	A	A	o	

JP Fiscal Year	Equipment/Material	Maker	Model	Q`ty	Unit Price(RM)	Amount (RM)	Unit Price(JPY)	Amount (JPY)	Place	Usage	Managem ent	Currennt Situation	Remarks
2000	High Speed cut-off Machine	HITACHI	CC16SB, 233003(20pcs)	1			132,400.00	132,400.00	Plant	A	A	o	
2000	Disc Grinder	MAKITA	9526B, Cutting wheelA00898(20pcs)	1			15,500.00	15,500.00	Plant	A	A	o	
2000	Drilling Machine	HITACHI	m), Streight Shank Drill(25pcs),Sleeve MTI(2Pcs), Taper	1			306,210.00	306,120.00	Plant	A	A	o	
2000	Crane	MANPEI, ZOJIRUSHI	Gantry Crane 2-4545, Chain Block HG-2	1			923,620.00	923,620.00	Machinaery Center	C	A	o	
2000	Chain Saw	MAKITA	Chain(5sets),Guide bar(1set),Chain oil(5pcs), Spark	1			104,270.00	104,270.00	Plant	C	A	o	
2001	Dust collector	AMANO	BV-2049	1	194,000.00	194,000.00			Plant	A	A	o	
2001	Insulation for hot air duct and dryer	Lab.N.Industries		1	21,600.00	21,600.00			Plant	A	A	o	
2001	Paddle agitator for E4	Lab.N.Industries		1	18,500.00	18,500.00			Plant	A	A	o	
2001	Buffer tank for G4 packer	Lab.N.Industries		1	3,500.00	3,500.00			Plant	A	A	o	
2001	Booster hot air supply system	Lab.N.Industries		1	67,100.00	67,100.00			Plant	A	A	o	
2001	Fan system for Solar dryer		Panel Fan Model LBP36 6units	1	17,700.00	17,700.00			Plant	A	A	o	
2001	Blower	Kawahara Engineering		12	2,733	32,800			Plant	A	A	o	

JP Fiscal Year	Equipment/Material	Maker	Model	Q`ty	Unit Price(RM)	Amount (RM)	Unit Price(JPY)	Amount (JPY)	Place	Usage	Managem ent	Currennt Situation	Remarks
2001	Forrage puddle driving machine	Lab.N.Industries		1	58,000	58,000			Plant	A	A	o	
2001	OPF Mixer (modification)	Kawahara Engineering	Modified	2	78,000	156,000			Plant	A	A	o	
2002	Forage Harvester	New Holland	TM125SP	1			18,400,000	18,400,000	Plant	C	A	o	
2002	Mixer/Mill and accessories	Spex	8000M-230	1	27,440				TSC	A	A	o	

Annex 1

I-4 Budget

(Unit: 1000yen)

Japanese FY	1996	1997	1998	1999	2000	2001	2002	2003	F/U Total	TOTAL
Local Budget										
General	300	3,200	3,800	4,405	4,000	3,500	5,299	6,015	11,314	30,519
Technology Application and Extenetion	0	0	0	822	920	1,582	1,085	0	1,085	4,409
Facility Improvement	0	0	0	0	0	0	9,382	0	9,382	9,382
International Seminar	0	0	0	0	0	0	625	0	625	625
LLDC Support	0	0	0	1,500	0	0	0	0	0	1,500
Emergency Support for Asian Economy Support	0	0	0	2,437	0	0	0	0	0	2,437
Extra Budget for the Plant	0	0	0	4,738	0	0	0	0	0	4,738
SubTotal	300	3,200	3,800	9,164	4,920	5,082	16,391	6,015	22,406	48,872
Provision of Equipment										
A4 request base	0	64,000	134,560	70,300	24,000	37,753	933	0	933	331,546
Accompanied with Experts	2,768	783	4,772	3,689	2,280		475	0	475	14,767
Sub Total	2,768	64,783	139,332	73,989	26,280	37,753	1,408	0	1,408	346,313

TOTAL	Yen	395,185

Annex 2 Input by Malaysian side

Cost Contribution from MARDI

1. Human Resources

   The total number of 35 counterparts is allocated at present. (2 from DVS are included. details in "MARDI Counterpart Allocation"). Besides counterparts, administration staffs and drivers also supported project activities or procedures for smooth operation of the Project.

2. Infrastructure

   No major construction took place during the F/U period. Building of work place and storage outside the processing plant was planned and has been under process. The budget for construction of the work place and storage is estimated RM 37,800.

3. Intensive Research Priority Area (IRPA) Project funds

   The amount of IPRA projects funds which are related to project activities are as follows:

   RM 249,048 (2002)

   RM 282,600 (2003)

   The Part of the fund was utilized for project activities through related counterparts. Items spent are experiments, analysis, traveling cost, allowance, contract worker, repair of equipment, renting and such.

   The cost for holding or attending seminars or expos is also covered by IRPA funds such as:

   -24th Malaysian Society of Animal Production (MSAP, 2002)

   -International Conference on Animal Feed (ICAN 2003)

   -2nd National Seminar on Livestock and Crop Integration (LCI) with oil palm (2003)

   -25th Malaysian Society of Animal Production (MSAP, 2003)

   -FAO 8th Meeting Workshop of the Regional Working Group on Grazing and Feed Resources for South East Asia (2003)

   - Farmer's Day (2003)

   - Expositions held at various states throughout 2002 – 2003

4. Cost of plant maintenance and operation

The total amount of RM 400,000 has been allocated for operation and maintenance of the plant for 2002 and 2003. The expenditure included the repairing of machineries, purchase of raw materials, fuel, packing bags and other consumables.

Contents of budget

Material	RM290,000-
Repair/Modification	RM 90,000-
Special Services	RM 20,000-
Total	RM400,000-

5. Administration

The total expenditure of SLRC including personnel are as follows

RM 1,020,000 (2002)

RM 4,015,000 (2003 up to September)

Utility cost was covered by MARDI. Four rooms in SLRC and one room in the Plant are provided for Japanese experts. Internet access was also supplied.

Annex 3 : Accomplishment Gird (1) / Input(1)

Category	Indicators	Source of Information	Evaluation Method	Accomplishment	Grade
Input(1)	**Japanese Side**				
	J-1:Japanese Experts				
	J-1-1 Amount	Personnel Input Record	Based on the record, confirmed whether the input was carried out as planned In terms of amount.	During the Follow-up period, three (3) Long-term experts, namely, Chief Advisor(24.0 (M/M)), Coordinator(15.3 (M/M)) and Agro-machinery(24.0 (M/M)), were dispatched. Also, Six(6) Short-term Experts (Evaluation of Feed Management(0.9 (M/M)), Toxicological Analysis and Product Safety(0.9 (M/M)), Plant Machinery(0.9 (M/M)), Simulation of Livestock Farming Model Management(0.9 (M/M)), Project Coordinator(6.5 (M/M)), and Livestock Management(0.4 (M/M)) were dispatched.	H
	J-1-2 Quality and Timing	C/P and J/E	Questionnaire/Interview about the degree of satisfaction of C/P and J/E in terms of the quality and timing of input.	It can be concluded that the timing of dispatch and ability of the experts were satisfactory based on the interview to the Malaysian counterpart staff. The duration of dispatch of Short-term experts was too short in some cases. For example, Coordinator was not assigned for three months from June 2003 to September 2003. However, the Long-term experts and C/P staff managed to implement the Project activities by helping each other.	H
	J-2:Counterpart's training				
	J-2-1 Amount	Personnel Input Record	Based on the record, confirmed whether the input was carried out as planned in terms of amount.	Despatch of Malaysian counterpart staff was made as requested and 10 counterparts were sent to Japan for training during the F/U period.	H
	J-2-2 Quality and Timing	C/P and J/E	Questionnaire/Interview about the degree of satisfaction of C/P and J/E in terms of the quality and timing of input.	In general, quality and timing of training are suited with the project purpose. Furthermore, the training stimulated the many C/P staff to change the mindset based on their experience in Japan in terms of team-work and discipline of Japanese people. Most trainees considered that the durations are suitable to achieve the target of training.	H
	J-3: Procurement of machinery and facilities				
	J-3-1 Amount	Equipment Record	Based on the record, confirmed whether the input was carried out as planned In terms of amount.	The procurement of machinery and equipment in terms of the amount, was carried out as scheduled. There was no serious problems reported.	H
	J-3-2 Quality and Timing	C/P and J/E	Interview about the degree of satisfaction of C/P and J/E in terms of the quality and timing of input.	In terms of "quality and timing", input was considered to be satisfactory during the F/U period.	H
	J-4 Assistance of local cost				
	J-4-1 Amount	J/E	Based on the financial records, to confirm as to whether the necessary input was carried out.	As of December 2003, approximately 22million Yen has been spent as assistance of local cost for renovation of OPF pilot plant, etc. This assistance contributed to the achievement of the Project.	H
	J-4-2 Quality and Timing	C/P and J/E	Question about the degree of satisfaction of C/P and J/E about the timing and subject of local cost assistance by Japanese Government.	It was confirmed that with the assistance to local cost assistance by the Japanese government was appropriate in terms of timing and quality. It contributed to the smooth implementation of the Project activities.	H

* Grades: H(High), M(Moderate), and L(Low) are put to help reader's understanding of the results, and they are not objective indicators such as points.
* Abbreviation 1: "C/P" = Malaysian Counterpart Staff" 2:"J/E"=Japanese Experts 3:"MARDI" =Malaysian Agricultural Research and Development Institute 4. "IRPA"=Intensive Research Priority Area

Annex 3: Accomplishment Grid (2) / Input (2)

Category	Indicators	Source of Information	Evaluation Method	Accomplishment	Grade
Input(2)	**Malaysian Side**				
	M-1 Land, building and facilities at the Project site				
	M-1-1 Amount	Site Inspection Input/Financial Record	Confirmed whether the input was carried out as scheduled, and the present condition.	A proper yard for OPF Plant, in terms of size and location, and the related facilities, as well as offices for the Japanese Experts, were provided by MARDI.	H
	M-1-2 Quality and Timing	Site Inspection, C/P and J/E	Questionnaire/Interview about the degree of satisfaction of C/P and J/E in terms of the quality and timing of input.	The above items are considered to be appropriate in terms of quality and timing.	H
	M-2 Allocation of C/P				
	M2-1 Amount	Counterpart allocation record	Based on the record, confirmed whether the input was carried out as planned In terms of amount.	In total, 35 C/P staff are allocated to the Project as of December 2003. Among them, five (5) staff were newly assigned after the commencement of the F/U period. Besides Besides C/P staff, administration staff and drivers are also allocated for smooth operation of the Project activities.	H
	M2-2 Quality and Timing	C/P and J/E	Questionnaire/Interview about the degree of satisfaction of C/P and J/E in terms of the quality and timing of input.	It can be concluded that the timing of dispatch and ability of the experts were satisfactory based on the interview to the Japanese Experts.	H
	M-3 Tools and other **M-3-1 Amount**	Equipment Record	Based on the record, confirmed whether the input was carried out as planned In terms of amount.	Necessary tools, materials, and appliances (desks and chairs, etc) and other consumable items have been provided by MARDI.	H
	M-3-2 Quality and Timing	C/P and J/E	Interview to C/P and J/E in terms of the quality and timing of input.	The above items are considered to be appropriate in terms of quality and timing.	H
	M-4 Operational cost				
	M-4-1 Amount	J/E and C/P, Financial Record	Based on the record, confirmed whether the input was carried out as planned In terms of amount.	A part of IRPA Project Fund was utilized for the Project activities. (FY 2002: RM 249,048= approx. 7.4 million yen. FY2003:RM 282,600 =approx.8.5 million yen.) Items spent on are experiments, analysis, travelling cost, allowance, contract workers, repair of equipment and renting, etc. Cost for holding/attending seminars or expos are also covered by the fund. The total amount of RM 400,000 (approx. 12 million yen) was allocated for O&M of the OPF plant for 2002 and 2003.	H
	M-4-2 Quality and Timing	J/E and C/P, Financial Record	Interview about the degree of satisfaction of C/P and J/E in terms of the quality and timing of input.	Sufficient amount of budget was allocated and executed. In particular, the budget for OPF harvester development and modification work of solar drying facilities was allocated at the final year of the 5-year project and the technology improvement on the two fields smoothly started at the beginning of F/U. It can be concluded that the quality and timing of Operational cost was appropriate.	H
		Final Note for Input Achievement			H
		Summary for Input Achievement **Input during the F/U period was appropriate.** Input was made appropriately by both Japanese and Malaysian sides. Technology transfer was efficiently made by Long and Short-term experts as well as through the training in Japan. Sufficient amount of budget was allocated and executed by the both sides. In particular, the budget for OPF harvester development and modification work of solar drying facilities was allocated by the Malyasian Goverment at the final year of the 5-year project and the technology improvement on the two fields promptly started at the beginning of F/U.			

* Grades: H(High), M(Moderate), and L(Low) are put to help reader's understanding of the results, and they are not objective indicators such as points.

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Annex 3: Accomplishment Grid (3) / Activities (1)

Category	Summary of Activities	Source of Information	Evaluation Method	Accomplishment	Grade
Activities (1)	**I-1. Improvement of feed processing system (1/2)** **1. Material Supply** **(1) Develop technology of harvesting/collection**	Project Report, J/E, C/P	Based on the information sources, evaluation team confirmed the achievement.	**Develop pikcup head of self-propelled type OPF harvester** 1) Scraper, small roll, large roll, and square roll type pickup headers were tested. The small and square roll types headers succeeded in picking up OPF while the harvester is moving. The patent of OPF harvester is now under process for application to SIRIM(Standards and Industrial Research Institute Malaysia) by MARDI. 2) C/P and research assistant acquired knowledges of the development/improvement process, i.e., trial making, performance test, and touch up, through development work of pickup head.	4
				Improve chipping performance of self-propelled type OPF harvester 1) Targeted chipped length of cut OPF, 10 to 30mm, was obtained under 6 blade units with drive gear combination of A17 and B19. The rate of chipping work ranges from 10 to 20 tons per hour under medium load. 2) Entanglement of weed during performance test in plantations was solved by modification of pickup roll. As a result, the rate of work reached 10 tons/hr or 2ha/hr.	4
				Testify field performance of developed OPF harvester in oil palm plantation C/P and research assistant acquired experiences of field performance test on OPF harvester in plantations. Operators of OPF harvesters improved their operation skills. The square roll type pick up head showed better performance than the small roll type.	4
	(2) Improve material handling and transportation	Project Report, J/E, C/P	Based on the information sources, evaluation team confirmed the achievement.	**Improve transportation system** Roll-On and Roll-Off transportation systems were reviewed and it was found out that combination of an OPF harvester with a dump lorry has obvious advantages, since the OPF harvester has functions of transportation, loading and unloading.	4
	(3) Improve pre-treatment method	Project Report, J/E, C/P	Based on the information sources, evaluation team confirmed the achievement.	**Analyze environmental condition in solar drying house** Temperature, relative humidity, and solar radiation were measured. Based on the data analyses, the solar drying house was modified into an open air house with 45 degree-inclined ventilation fan installed. Consequently, enhanced drying technology, by the use of solar heat and air ventilation blown in the house, was developed.	4
				Modify mixing equipment (agitator) Rotational and travelling speed of the agitator was increased tow times as fast as the original agitator. As a result, 6 tons of fresh OPF, with moisture contents from 65 to 70%, could be dried to 35% in 2 days and 15% moisture content in 3 days, if the weather conditions are met.	4
				Figure out energy consumption and drying cost through solar drying experiment 1)Research assistant C/P staff acquired technical skills on operation of solar drying facilities, sampling collection and moisture content determination through the experiments. 2) Under the experimental conditions, drying cost was calculated and then the method was approved as a practical drying technology. The result of drying experiments was reported and information on solar drying was shared with C/P staff. The results were also presented at seminars and conferences.	4

* Grades: 4:accomplished, 3:expected to be accomplished during the F/U period, 2:will not be accomplished in the F/U period, 1:not started

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Annex 3: Accomplishment Grid (4) / Activities (2)

Category	Summary of Activities	Source of Information	Evaluation Method	Accomplishment	Grade
Activities (2)	**I-1. Improvement of feed processing system (2/2)**	Project Report, J/E C/P			
	2. Pilot Plant (1/2)				
	(1) Improve planning and setting	Project Report, J/E C/P	Based on the information sources, evaluation team confirmed the achievement.	Completed in the previous five-year Project period.	
	(2) Improve processing system	Project Report, J/E C/P	Based on the information sources, evaluation team confirmed the achievement.	**Artificial drying of OPF: Performance Test** 1) Drying experiments were carried out using fresh OPF and partially solar dried OPF. C/P and research assistant acquired operational skills on the artificial dryer, preparation of experiments, and moisture determination through the experiments. 2) Modification remains on the dryer so that the temperature of the dryer will increase.	3
				Performance Test of Hammer Mill Mesh/screen was found to be able to cut material at the optimum length.	4
				Material flow and supply: Modify equipments and machinery of processing 1) Modification works, as follows, were conducted on several equipments and bins to reduce clogging and bridge of raw material caused by the improper basic design. *Sump pit, located between drying bay and conveyer, was facilitated with automatic water drain pump. *Slanting conveyer was replaced with a new one with lug. *The length of the slanting conveyer from feed hopper was reduced and was equipped with over flow rejecting roller brush. *Rotating reels were installed in the feeding hopper. *Oscillation type shifter was demolished and a square shaped chute was newly installed. 2) Plant coordinator, research assistant, and Japanese expert exchanged opinions and information on necessity of modification, design point, and specification of the works.	4
				Modify some of equipments relating to material mixing line 1) Modification works was done on scale hopper, temporal storage bin, and so on. As a result, mixing operation could be continuously done. Moreover, final products discharge units were effectively modified. The listed below is the works. *Agitation pedal and observation windows were installed in OPF temporal bin. *Inner wall of hopper scale was modified into straight type. *Discharge unit of final products tank was modified into conveyer type discharge system. 2) Plant coordinator, research assistant, and Japanese expert exchanged opinions and information on necessity of modification, design point, and specification of the works, as well.	4
				Evaluate performance of processing machinery after modification By use of solar dried OPF and premixed materials, performance of feed formation was 2 ton /hr.	4

* Grades: 4:accomplished, 3:expected to be accomplished during the F/U period, 2:will not be accomplished in the F/U period, 1:not started

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Annex 3: Accomplishment Grid (5) / Activities (3)

Category	Summary of Activities	Source of Information	Evaluation Method	Accomplishment	Grade
Activities (4)	**I-1. Improve feed processing system** **2. Pilot Plant (2/2)**				
	(3) Evaluate plant management	Project Report, J/E C/P	Based on the information sources, evaluation team confirmed the achievement.	**<u>Evaluation of machinery layout :Enlightenment of plant management to plant staff</u>** 1)Five (5)S was introduced as a first step of factory management. Activities are as follows. *Observation tour of good example factories (Ajinomoto and Otofin machinery) *5S and Kaizen (Improvement) seminar *Monthly Gotong-Royong (Big-Sweeping by mutual cooperation) *Weekly meeting *Sorting and Set in order in workshop and spare-parts storage * Utilization of white board *Visualization of garbage box by yellow line and switch of electrical equipment by labelling 2) Pulley replacement, tapping, adjustment of V-Belt and chain, and so on were performed in daily work with expert. Addition to that, technical training relating to repairing work were conducted as follows. *Arc welding and gas cutting *Machinery tools *Foliage cutter disassembling/reassembling 3) Plant management manual (Draft) was made up.	4
				<u>Evaluation of plant operation and plant management</u> Plant coordinator understood the importance of a good plant management. Some of progress on plant management has been observed because of workers attitude and maintenance work were enhanced by training on skill and seminars on management.	4

* Grades: 4:accomplished, 3:expected to be accomplished during the F/U period, 2:will not be accomplished in the F/U period, 1:not started

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Annex 3: Accomplishment Grid (6) / Activities (4)

Category	Summary of Activities	Source of Information	Evaluation Method	Accomplishment	Grade
Activities (5)	**I-2. Improvement of feed quality**				
	(1) Conduct raw material analysis	Project Report, J/E C/P	Based on the information sources, evaluation team confirmed the achievement.	Completed in the previous five-year Project period.	----
	(2) Conduct product analysis	Project Report, J/E C/P	Based on the information sources, evaluation team confirmed the achievement.	**Assess chemical properties of OPF based Total Mixed feed products** 1) Optimum mixing ratio of TM feed for each growing stage of both beef cattle and milk cow was determined. 2) The patent for OPF based TM feed is under the process by MARDI to SIRIM(Standards and Industrial Research Institute Malaysia).	4
				Analyze heavy metal contamination in OPF and OPF based Total Mixed feed 1) Activities of this part was conducted by C/P training in Japan and dispatching of short-term Japanese expert. Technology transfer was done for heavy metal analysis. Through the analysis, Pb concentration in OPF based feed was found to be within Japanese safety level as less than 3mg/kg. 2) Result of the analysis was presented at Malaysian Society of Animal Production (MSAP) in August 2003.	4
	(3) Improve nutritive values	Project Report, J/E C/P	Based on the information sources, evaluation team confirmed the achievement.	Completed in the previous five-year Project period.	----
	(4) Conduct product evaluation	Project Report, J/E C/P	Based on the information sources, evaluation team confirmed the achievement.	**Analysis of Product :Improve the uniformity in chemical composition** 1) OPF Quality Check Manual for OPF Products was published as project publication to establish stable quality production technology. Through technology instruction, processing quality control can be conducted.	4
	II. Improve feeding management (1/2) **(1) Prepare a plan of experiments**	Project Report, J/E C/P	Based on the information sources, evaluation team confirmed the achievement.	Completed in the previous five-year Project period.	----
	(2) Conduct feeding experiments	Project Report, J/E C/P	Based on the information sources, evaluation team confirmed the achievement.	**Conduct feeding experiments on dairy cattle at an institutional farm** Feeding experiments were conducted at a farm of Dept. of Veterinary Service. As a result, OPF- TM-Cube, (containing 30% of OPF and other feeding gredinets) is well balanced and has shown advantages.	4
				Conduct feeding experiments on beef and dairy cattle at a private farm 1) OPF-TM-Cube was tried at oil palm plantation companies, JTOP and YPJ, and the result showed that weight increase was almost twice as of control feed. OPF-TM-Cube is more suitable for Brahman breed. 2) Same experiment was conducted at a private farm keeping 5 to 10 heads of milk cattle. There was no significant difference on quality and quantity of milk compared with control. Feeding operation of OPF-TM-Cube showed effectiveness in terms of labour saving.	4
	(3) Improve feeding technology	Project Report, J/E C/P	Based on the information sources, evaluation team confirmed the achievement.	**Conduct inspection of beef quality fed with OPF based animal feed** Beef quality inspection was performed by use of ultra-sonic scanner and slaughtering. As a result, beef cattle fed with OPF feed in ribeye area was likely to be larger as compared with conventionally fed cattle beef.	4

* Grades: 4:accomplished, 3:expected to be accomplished during the F/U period, 2:will not be accomplished in the F/U period, 1:not started

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Annex 3: Accomplishment Grid (7) / Activities (5)

Category	Summary of Activities	Source of Information	Evaluation Method	Accomplishment	Grade
Activities (6)	**II. Improve feeding management(2/2)** **(4) Conduct feeding management system evaluation**	Project Report, J/E C/P	Based on the information sources, evaluation team confirmed the achievement.	**Conduct survey of labour and facility for feeding system for beef cattle** Survey was conducted to examine feeding management with OPF TM cube at JTOP, a private oil palm plantation firm. Utilization of OPF TM cube could show effectiveness on saving feeding work.	3
				Conduct survey of labour and facility for feeding system for dairy cattle Survey on OPF TM cube feeding operation work was conducted at small-scale livestock farm household. Labour of preparation for feed was saved compared with conventional feeding method.	3
				Compile feeding management manual for beef and dairy cattle Feeding management manual for beef and dairy cattle was made based on experimental data. Content of the manual was subjected to livestock farmer and extension officers.	4
				Simulation of economical and simple livestock farming by OPF completed feed Short-term expert supported the activity. OPF TM feed utilization was advantageous as compared with wet grass feeding for large-scale dairy farming. The above feeding system was also clearly advantageous for beef cattle livestock farming if daily increase of weight is improved 5 to 10 %.	4
	III. Economic evaluation of OPF production **(1) Conduct cost analysis**	Project Report, J/E C/P	Based on the information sources, evaluation team confirmed the achievement.	**Feasibility of OPF pilot plant: Plan cash flow of OPF pilot plant** According to the previous OPF feed production cost analysis before modification work, chipped raw material and artificial drying together with pelleting account for 33% and 50% in the cost structure, respectively. Therefore, improvement of performance for both collection and solar drying work was proceeded. After modification and improvement, production cost structure analysis was conducted and much cost reduction was recognized.	4
	(2) Conduct comparative study of feed	Project Report, J/E C/P	Based on the information sources, evaluation team confirmed the achievement.	**Predict viability of OPF plant as a business plant** Production cost analysis was conducted under the following conditions. 1) 225ha of OPF harvesting area, and, 2) production capacity of 30 tons/day for 2,000 heads of cattle.	4
		Final Note for Activity Achievement			4
		Summary for Activities Achievement **The degree of achievement of each activity during the F/U period was satisfactory.** Most of the activities namely, 1) improvement of feed processing system (material supply, and pilot plant), 2) improvement of feed quality, 3) improvement of feeding management, and 4) economic evaluation, were well achieved during the limited time of the F/U period. Although a part of the activities such as "survey of labour and facility for feeding system for beef and dairy cattle" has room for improvement and continuation and accumulation of field data are necessary, as a whole the achievement of the Project activities is highly evaluated.			

* Grades: 4:accomplished, 3:expected to be accomplished during the F/U period, 2:will not be accomplished in the F/U period, 1:not started

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ANNEX 3: Accomplishment Grid_(8) / Outputs / Project Purpose

Category	Indicators	Source of Information	Evaluation Method	Accomplishment	Grade
Outputs					
1. The methodology for processing oil palm fronds and other by-products of oil palms into processed feed is developed	(1) The pilot plant processes 2,000 tons of OPF feed yearly. (2) Comparable quality to conventional fibrous feed product	Project documents, C/P, J/E , Site Inspection	Confirm accomplishment with various documents and interview results.	(1) Assessment on the capacity of the plant indicated that the pilot plant has a technical and potential capability of producing 2,000 ton/year (assuming that 2 tons/hr x 5 hr/day x 200 days/yr = 2,000 ton/yr). However, there were limiting factors that constrained the accomplishment of the targeted Output. They were i) limited supply of OPF raw material from UPM plantation, ii) pilot plant was operated basically on experimental/research basis for performance test of the production technology and was not operated continuously, and iii) the demand of OPF feed was not sufficient to produce the quantity that could be potentially generated by the plant. During the F/U period, the improvement of the material collection and solar drying technology had increased significantly the processing capacity of the pilot plant and the hourly production rate has exceeded 2 tons/hr. As a result, it was estimated that the pilot plant has a potential of producing 2,000 tons/year. (2) The lead (Pb) content was verified less than 3 ppm (safety level by Japanese standard) by ICP-MS measurement.	4
2. An appropriate method of animal feeding management on the processed feed is developed.	OPF feeding standardization for beef and dairy cattle.	Project documents, C/P, J/E	Confirm accomplishment with various documents and	As for beef cattle, OPF-TM-Cube was tried at large scale farms, such as oil palm plantation companies, and the result showed that weight increase was almost twice of the control feed. As for dairy cow, experiments were conducted at small farms. As a result, OPF-TM-Cube that involved mixing of OPF and other by-products to produce well balanced feeds and has shown some advantages in increasing milk yield. Feeding management manual for beef and dairy cattle with OPF based feeds was made based on feeding experimental data.	3
3. The viability of the processed feed for practical use is verified.	Market Competitiveness	Project documents, C/P, J/E	Confirm accomplishment with various documents and interview results.	A simulation carried out based on the potential output of the pilot plant showed that the production cost of 100% OPF was estimated to be RM157 per ton (cube production efficiency at 30 tons/day) while the cost for OPF-TM cube was RM414 (cube production efficiency at 30 tons/day). This was lower than the market price of most other feedstuffs such as rice bran, hay and wheat pollard in Malaysia.	3
	Final Note for Outputs Achievement				4
	Summary for Outputs Achievement **Achievement of Outputs are judged to be satisfactory for the F/U period.** It is judged that the pilot plant has a theoretical potential of producing 2,000 ton/year. Although pilot plant capacity did not reach the target amount due to the reasons mentioned above, the production capacity per hour reaches 2 ton with supplemental use of solar dried OPF chips. As regards the methodology for animal feeding management, a manual was prepared and published, and competitiveness of OPF feed was verified under a certain conditions. Thus, most of the outputs were achieved successfully.				
Project Purpose: **Effective, practical, and viable method and system for converting by-products of oil palms into processed feed are developed.**	*Package technology available *Nos..of enquiries on OPF feed * User's Confidence	Project documents, C/P, J/E	Confirm accomplishment with various documents and interview results.	Project purpose achievement is judged to be satisfactory because, i) OPF based feeds processing system was developed through fully mechanized technology for collection and solar drying, ii) more than 13 organizations requested to produce OPF feeds and OPF feeds have been constantly delivered to 3 organizations, and, iii) OPF based feeds have been well received by the users in the domestic market covering both public and private sectors.	3
	Final Note for the Project Purpose Achievement				3
	Summary for Project Purpose Achievement **Project Purpose achievement was satisfactory during the F/U period.** It can be judged that the Project purpose has been accomplished satisfactorily during the F/U period. As described above, by improving each component of the package technology, i.e., material supply, drying, plant processing, animal feeding, and economic evaluation, the quality of the OPF based feed has been more secured now. Although the technology has not been fully promoted or disseminated to end users yet, it has already drawn attention from relevant statutory bodies. User's confidence was partially verified based on the field experiment, but continuation of the field experiment/survey and accumulation of data is necessary for future dissemination of technology.				

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ANNEX 3: Evaluation Grid_(1) / Relevance

Category	Evaluation Item	Source of Information	Evaluation Method	Evaluation	Grade
Relevance	**1. Relevance of the Project for Malaysian Government Policy**	Interview to C/P, J/E	Confirm as to whether the Project is still meaningful along with the current Malaysian national policy	Relevance of the Project Purpose and Overall Goal The Project Purpose and Overall Goal have high degree of relevance to the National Policy. In Malaysia, 75% of beef, and 95% of milk or related products are imported. The Malaysian government is planning to raise self-sufficiency level by doubling the domestic production by 2010. On the other hand, ruminants like cattle need to be fed pasture or feed crop containing high fibre; however, very few high quality pasture or feed crop can be found in tropical and wet climate like Malaysia. The shortage of high quality feeds will affect the overall production of livestock. Thus, utilization of oil palm fronds (OPF) into animal feeds will support the increase of livestock or dairy production and it is consistent with the Malaysian policy. Meanwhile, the Third National Agricultural Policy (NAP3) aims at enhancing food security by increasing agricultural production. The Project purpose has components of 1) development of high quality feeds for ruminant based on oil palm by-products, 2) evaluation of the feeds and 3) development of feeding and management of the feeds. The project planning was relevant as it provides complete package technology right from the production of OPF based feeds to the level of utilization in livestock.	H
	2. Relevance of the Project for implementing institutions	Interview to C/P, J/E	Confirm as to whether the project is still meaningful for the current situation of MARDI?	The Project had much significance to the MARDI both in technology transfer and human resources development. The project is in line with mandate of the Institute. For example, in Mar.2003, International Conference on Animal Nutrition was held and the majority of the topics presented were related to the Project outcomes.	H
	3. Relevance of the Project for the local resident's needs	Interview to C/P, J/E	Confirm as to whether the project is still meaningful for the residents in the target areas?	From the characteristics of the Project (new technology development at experimental level), it has not shown much direct and visible significance to local residents' needs, at the moment. However, since the Project is trying to utilize OPF, which has not been effectively utilized so far, to increase self-sufficiency of beef and milk, etc., it is considered that the Project has high degree of relevance to the needs of the Malaysian society in the future.	M
		Final Note for Relevance			H
		Summary for Relevance **Relevance of the Project implementation is High.** The Project Purpose and the Overall Goal of the Project have a high degree of consistency to the national agricultural policy of Malaysia and the needs of the society. In Malaysia, 75% of beef, and 95% of milk or related products are imported. The Malaysian government is planning to raise self-sufficiency level by doubling the domestic production by 2010. On the other hand, ruminants such as cattle need to be fed with pasture or feed crop containing high fiber. However, high land opportunity cost prevents cultivation of pasture crops. This shortage of supply of high quality raw materials for feeds will affect the overall production of livestock. Thus, utilization of OPF into animal feeds will support the increase of livestock and dairy production and is consistent with the Malaysian policy and also the needs of livestock farmers. However, the project has not shown much direct and visible contribution or significance to local population at the moment. Nevertheless, the Project is trying to exploit the use of OPF to increase the food supply, which can subsequently contribute to increase the self-sufficiency of beef and milk, etc. Therefore, it is considered that the Project has high relevance to the needs of Malaysia. The Project also has contributed greatly to the transfer of knowledge to the C/P personnel of MARDI through the OJT (On-the-Job Training) and training in Japan.		

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ANNEX 3: Evaluation Grid_(2) / Effectiveness / Efficiency

Category	Indicators	Source of Information	Evaluation Method	Evaluation	Grade
Effectiveness	**1. Achievement of the Project Purpose**	Accomplishment Grid, C/P, J/E,	Confirm as to whether the project purpose would be achieved.	It can be concluded that the Project purpose has been accomplished satisfactorily during the F/U period. Through the improvement of each component of the package technology, i.e., material supply, drying, plant processing, and animal feeding, the quality of the OPF based feed has been found to be more consistent. Although the technology has not been fully promoted or disseminated to end users, it has already drawn attention from relevant statutory bodies. User's confidence was partially verified based on the field experiment, although continuation of the field experiment/survey and accumulation of data is still necessary for future dissemination of the technology.	H~M
	2. Contribution of outputs to Project Purpose	Accomplishment Grid, C/P, J/E, Project document, etc.	Confirm as to whether the outputs contributed to the achievement of the Project purpose.	In the F/U period, outputs generated through technology improvement in Material Supply, Solar Drying, Pilot Plant, Feed Quality Evaluation, Feeding Management, directly contributed to the Project Purpose achievement as well as Economic Evaluation of OPF production. There was no external or incidental factors to be considered.	H
		Final Note for Effectiveness			H
		Summary for Effectiveness **The Effectiveness of the Project during the F/U period is High.** In the F/U period, almost all activities carried over from 5-year project were undertaken and the remaining issues were dealt with efficiently. The remaining issues include improvement of the drying system by solar energy, improvement of OPF pilot plant and introduction of new plant management technique. As a result of the renovation, stable production OPF feed production was achieved through a "package technology" and the pilot plant has a sufficient technical and potential capacity to meet the targeted demand of the OPF production. In addition, through the "5S" and "KAIZEN" activities, the pilot plant staff has learned the basics of quality control and management skills. Feeding experiments on OPF feeds were conducted at institutional farms and selected private farms. As a result, practical feeding technique was developed.			
Efficiency					
	1. Comparison of outputs with inputs	C/P, J/E	Confirm as to whether the quantity of input can be justified by comparison of output from Expert's point of view	As long as the F/U period is concerned, efficiency of the Project was high. Improvement of material supply, plant system, etc. were significant and transfer of technology was successfully executed to Indonesian counterpart staff.	H
	2. Combination of Inputs	C/P, J/E	Confirm as to whether inputs contents and level are proper or not from a view point of Malaysian counterpart staff.	Combination of inputs, namely, inputs of experts for transfer of technology and dispatch of counterpart staff to Japan, or collaboration with forest plantation companies, are considered to be appropriate to generate outputs effectively.	H
	3. Any linkage with other type of cooperation which promote the efficiency	C/P, J/E	from overseas or other projects in Malaysia?	There was no significant linkage with other type of cooperation.	----
		Final Evaluation for Efficiency			H
		Summary for Efficiency **Efficiency of the Project during the F/U period is High.** During the F/U period, inputs were delivered mostly on time by both sides, and substantial improvement was made in various technical aspects. On the Japanese side, there was an absence of a Coordinator for three months from June 2003 to September 2003. However, the long-term experts and C/P staff managed to implement the Project activities by assisting each other. The budget for the OPF harvester development and the modification work of the solar drying facilities was allocated in the final year of the 5-year project, contributing to the prompt technology improvement on the two fields at the beginning of the F/U period.			

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ANNEX 3: Evaluation Grid_(3) / Impact

Category	Indicators	Source of Information	Method	Evaluation	Grade
Impact	**1. Possibility to accomplish the Overall Goal of the Project**	C/P, J/E, Project Documents	Confirm the relevant through interviews as to whether the overall goal of the project seems to be met eventually. In addition, an observation study is conducted by a member of the evaluation study team.	The Overall Goal is considered difficult to be achieved. There is a big gap between the Project purpose and the Overall Goal. Therefore, in the long-term, various supporting activities, and coordination among the related governmental organizations will be necessary to achieve the Overall Goal. Specifically, in order to make progress towards the Overall Goal, it is necessary that measures for disseminating the developed technology be taken by MARDI in coordination with other related governmental organizations. The incubator system, which is now under preparation for implementation, will be a prime force for technology dissemination by MARDI. The prospects for sustainability would be higher if the incubator system is successfully implemented.	—
	2. Impact to residents	C/P, J/E, Project Documents	Confirm the relevant as to whether there has been impact to residents.	From the characteristics of the Project, it has not generated significant visible impact to local residents, so far. However, since the Project is trying to utilize OPF, which has not been effectively utilized so far, to increase self-sufficiency of beef and milk, etc., it is considered that the Project will cause a positive impact in the future. In terms of this issue, the necessity for creating integrated livestock management and production of OPF feed in oil palm plantation has been presented and gained a lot of attention during the "International Conference on Animal Nutrition" and "2nd National Seminar on Livestock and Crop Integration (LCI) with Oil Palm".	—
	3. Impact to institutions	C/P, J/E, Project Documents	Confirm the relevant as to whether there has been impact to implementing institutions.	There was a significant impact to the implementing institutions. By implementing the Project, which handles OPF, a new material of animal feed, which has not been utilized for animal feed, various scientific and engineering findings were made. As a result, three patents have been submitted to SIRIM by MARDI in coordination with JICA. Also, more than 30 publications/paper related to the Project were prepared. As regards the staff of the processing plant, besides the technology transfer through the improvement of processing line, plant management skills including safety control, maintenance, and quality control were acquired through "5S" or "KAIZEN" activities.	—
	4. Impact to policy	C/P, J/E, Project Documents	Confirm the relevant as to whether there has been impact to policy.	Significant impact to policy has not been observed at this moment since the dissemination of the technology has not been started yet.	—
	5. Other impact	C/P, J/E, Project Documents	Confirm the relevant to describes freely as to what and how the project bring any change around the area, etc.	Significant impact to other areas has not been observed since the dissemination of the technology has not been started yet.	—
		Final Note for Impact			
		Summary for Impact **At the time of final evaluation, positive impacts to implementing institutions are observed.** 1) The Overall Goal is considered difficult to be achieved within a short period. There is a big gap between the Project purpose and the Overall Goal. Therefore, in the long term, various supporting activities, and coordination among the related governmental organizations are necessary to achieve the Overall Goal. 2) By developing the technology to handle OPF as a new source of raw material for animal feed, various scientific findings and engineering technologies were successfully generated. Based on the findings and the technology development, more than 30 publications or papers related to the Project were documented. These facts reinforced the confidence of MARDI on the OPF product. As a result, MARDI has decided to initiate the "incubator system" for transfer of technology to the industry. extend the technology by themselves. 3) Based on the findings and technologies developed, application for three patents have been submitted by MARDI to SIRIM (Standards and Industry Research Institute, Malaysia) in collaboration with JICA. Intellectual property which will be obtained through the Project activity is expected to enhance the financial standing of MARDI in the future. In addition, the staff of the pilot plant also acquired plant management skills including safety control, maintenance, and quality control through "5S" and "KAIZEN" activities in addition to the technology transfer. This has improved the mutual understanding among staff and has greatly contributed to the collaborative effort in the plant.		

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ANNEX 3: Evaluation Grid_(4) / Sustainability

Category	Indicators	Source of Information	Evaluation Method	Evaluation	Grade
Sustainability	**1. Institutions**				
	1-1. Capability of implementing Institutions	C/P, J/E	Check the capability of MARDI to continue the Project activities on their own.	The capability of MARDI to continue the Project activities is considered sufficient. MARDI (Malaysian Agricultural Research and Development Institute) is a statutory body holding 2,800 staff including 400 researchers. It undertakes research and development (R&D) in food and tropical agriculture, and its R&D efforts for over more than two decades have contributed to the development of new crop varieties/clones and animals breeds, and their husbandry practices. Besides implementing contract R&D projects, MARDI also provides related technical and entrepreneurial development services relevant to food, agriculture and related service industry. SLRC, the direct implementing agency of the Project, is one of the seven research centres under MARDI. SLRC has about 30 researchers and 75 supporting staff and working on breed improvement, livestock feed, and related production system.	H
	2. Finance				
	2-1. Financial conditions of MARDI **3.Technology**	C/P, J/E	Check the financial conditions of MARDI to implement	Although financial allocation of MARDI, as running cost, has been satisfactorily contributed to the progress of the Project activities, in order to maintain the production of OPF feeds in the plant, the amount of cost required is high on material supply, transportation and operation. For the management of the plant, institutional support on budget or management is required. It is necessary that further actions will be taken on the incubator system.	H
	3-1. Possibility for C/P to manage the activities for MARDI	C/P, J/E	Possibility for C/P to manage the activities for fish culture improve technology development was examined through interviews.	Usually a production plant is maintained systematically in 5-year cycle by daily checking, monthly or annual checking and management, or overhaul. Small or big troubles are fixed and each part is improved and renovated. In the Project, setting and operation of machineries were transferred but plant management was started in the F/U period. Since at least 5 year is required for maintenance or management of plant, sustainability in technical aspects remained uncertain.	H~M
	Final Note for Sustainability				H~M
	Summary for Sustainability evaluation **It is considered that the sustainability of the Project is Satisfactory.** 1) MARDI is an outstanding research institution in Malaysia with 2,800 staff. The counterpart staff assigned to the Project are capable and gained a lot of experiences through the Project implementation. Therefore, it is considered that MARDI has sufficient capability to continue the Project activities independently after the termination of the cooperation period. However, the following aspects are considered important for the sustainability of the Project: 2) Although financial allocation of MARDI for operational costs has satisfactorily contributed to the progress of the Project activities, but in order to maintain the production of OPF feeds in the pilot plant, the amount of cost required will be high for material supply, transportation and operation. For the management of the pilot plant, institutional support for budget as well as management is required. 3) Extension/dissemination of the technology and the production of OPF feeds by private sectors through incubator system are crucial to sustain the positive effect of the Project. Recently, the inquiry from oil palm plantations has been increasing. However, detailed plan of the incubator system has yet to be developed. It seems that a bit more time is required before this technology could be introduced and transferred to private sectors through MARDI.				

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ANNEX 4: Project Design Matrix for Evaluation

Project Name: Project for Development for Development of Technology Related to Processing of Feed Based on Agro-industrial By-Products of Oil Palms in Malaysia
Project Period:Two years from March 2002 (Follow-up Period)
Project Area: MARDI Target Group: MARDI staff Prepared in December 2003

Narrative Summary	Verifiable Indicators	Means for Verification	Important Assumptions
[Overall Goal] The livestock industry in Malaysia is developed through the stable supply of feed based on agro-industrial by-products of oil palms.	Demand for processed OPF feed		*There will be no change in Malaysian Government policy in agro-production National Agricultural Policy (NAP3) aims at maximizing income of producers through the optimal utilization at resources, thus maximizing agriculture's contribution to national income and export earnings.
[Project Purpose] Effective, practical, and viable method and system for converting by-products of oil palms into processed feed are developed.	*Package technology available *Nos. of enquiries on OPF feed * User's Confidence	*Interview to Japanese Experts, C/P staff *Review of the Project Report *Interview to entrepreneurs, etc.	*Neither natural disasters nor new type pests affecting oil palm production will occur. *There will be smooth growth of consumption in livestock products in Malaysia.
[Outputs] 1. The methodology for processing oil palm fronds and other by-products of oil palms into processed feed is developed.	(1) The pilot plant processes 2,000 tons of OPF feed yearly. (2) Comparable quality to conventional fibrous feed product	*Interview to Japanese Experts, C/P staff *Review of the Project Report	*The developed technology will be accepted for use by the local private enterprises. *The MARDI organization will not change drastically.
2. An appropriate method of animal feeding management on the processed feed is developed.	OPF feeding standardization for beef and dairy cattle.	*Interview to Japanese Experts, C/P staff *Review of the Project Report	*The MARDI budget will not decrease to great extent.
3. The viability of the processed feed for practical use is verified.	Market Competitiveness	*Interview to entrepreneurs, etc.	*The cost for OPF materials will not rise sharply.

[Activity]	[Input]		
	Japanese side	**Malaysian side**	There will be no significant change in allocation of MARDI C/Ps.
1-1.Improve feed processing system Material supply (1) Develop technology of harvesting/collection (2) Improve material handling and transportation (*) (3) Improve pre-treatment method Processing plant (1) Improve planning and setting (*) (2) Improve processing system (3) Evaluate plant management 1-2. Improve feed quality (1) Conduct raw material analysis (*) (2) Conduct product analysis (3) Improve nutritive values (*) (4) Conduct product evaluation 2. Improve feeding management (1) Prepare a plan of experiments (*) (2) Conduct feeding experiments (3) Improve feeding technology (4) Conduct feeding management system evaluation 3. Evaluate economic feasibility of OPF production (1) Conduct cost analysis (2) Conduct comparative study of feed (*) Note: Activities with (*) were complete during the 5-year project period.	**1. Dispatch of experts** Long –term expert *Chief Advisor:1 (24.0 M/M) *Coordinator:1 (15.3 M/M) *Agro-machinery:1 (24.0 M/M) Short-term Experts *Evaluation of Feed Management:1(0.9 M/M) *Toxicological Analysis and Product Safety:1(0.9 M/M) *Plant Machinery:1(0.9 M/M) *Simulation of Livestock Farming Model Management:1(0.9 M/M) *Project Coordinator:1(6.5 M/M) *Livestock Management:1(0.4 M/M) **2. Provided Equipment** Machinery for OPF harvesting etc. Approx. 26 million Yen **3. C/P training in Japan** (10 in total) *Evaluation of Feeding Managemen:1 *Livestock Management:2 *QC in Heavy Metal:1 *Mechanization and Drying :1 *Agricultural Machinery:1 * Plant Machinery :4 **4. Local Cost Assistance** Renovation of the OPF Plant, etc. Approx. 22 million Yen	**1.Allocation of C/P staff** (35 in total) *Project Director *Project Manager *Feed Evaluation *Heavy Metal Analysis in Feed *Plant Machinery *Agricultural Machinery *Animal Feeding Management *Plant O&M (*) and Management *Administrator *Drivers **2. Land and Buildings, etc.** Yard for OPF Plant, Office for Experts, etc **3. Local Cost** Infrastructure Improvement RM37,800 (1.1 million l yen] Running cost for OPF Plant, etc. IRPA Project Fund for the Project activities. RM 249,048 (7.4 million. Yen: 2002): RM 282,600 (8.5 million. Yen: 2003) O&M cost for the OPF plant for 2002 and 2003. RM 400,000 (12 million. Yen).	Pre-conditions; 1.The project will be accepted by the Malaysian Government and the relevant organization 2.Oil palm fronds will be uninterruptedly supplied as feed material.

Annex 5 Recommendation of Final Evaluation and Feedback made by the Project

(**Bolded** paragraph is feedback.)

Recommendation

The Committee recommends that Japanese and Malaysian government should take the following measures to achieve the project purpose successfully and make the Project self-sustainable after the termination of cooperation.

1) The committee strongly recommends that the follow-up for the Project should be conducted for another two of years until March 14th, 2004. Proposal for the follow-up program of the Project is summarized in ANNEX 5. The following activities need to be further carried out in cooperation with JICA.

Follow-up (F/U) Project, concentrating on activities listed below have been implemented as described in the following follow-up program sheet as attached. The activities were planned based on recommendation as listed in paragraph 1), for 2 years term from 15 March 2002 to 14 March 2004.

A. Improvement of material supply

More activities need to be carried out for the improvement of material harvesting and handling system, as well as pre-drying capacity of the OPF in order to reduce cost.

As for activity of material supply, the following activities were planned and conducted after the allocation of the. High efficiency mechanization technology on harvesting/collection of OPF and cost effective solar drying technology were developed as outcomes of 2-year activities. Performance of the both areas are very much superior to those achieved in the previous 5-year project.

1. Development of OPF harvesting/collection technology OPF

1-1. Development of pickup head and an OPF harvester

1-2. Development of high efficiency chipping technology to cut OPF into optimum length by the OPF harvester

1-3. Establishment of high efficiency harvesting/collection and transportation technology by the self-propelled OPF harvester

2. Development of solar drying technology

2-1. Development of solar drying house

2-2. Development of mixing/agitation technology for solar drying

2-3. Establishment of drying technology for chipped OPF by use of solar heat

B. Improvement and evaluation of processing system

More activities need to be undertaken to establish machinery's capacity of each component, and improve the system of the plant.

The following activities as listed below were implemented in the areas of the OPF processing plant modification and establishment of stable animal feed production technology. Apart from machinery and equipments, components of the processing plant, especially those functioning for conveying materials have exposed some problems highly associated with mal-designing. A special budget was therefore allocated by JICA for the modification works.

3. Development of OPF feed processing technology at the processing plant

3-1. Development of an efficient artificial drying technology

3-2. Development of OPF stable-quantity feeding technology by use of a feeding hopper

3-3. Development of stable conveying/transportation technology

3-4. Development of OPF feed stable production line

4. Development OPF feed processing machinery operation, maintenance, and management technology

4-1. Establishment of operation skill for OPF feed processing machinery

4-2. Establishment of repair, maintenance, and improvement technology

4-3. Establishment of the processing plant management technology

The activity on the establishment of the processing plant management technology was not planned in the 5-year project. It was newly added to the F/U Project as it was necessary to acquire not only the operation skill but also the skill and knowledge on checking-up and repair of the major equipment and other areas with regard to, improvement idea (KAIZEN), maintenance, safety awareness, and product quality management in order to ensure the smooth running of practical and large-scale animal feed processing plant smoothly.

C. Improvement of feed quality

More activities need to be conducted to monitor the Pb level in OPF products.

As a result of activity, analysis of heavy metal was especially defined by ICP-MS in the F/U project. This is very important from the viewpoint of safety of feed both for domestic and exports markets which justify stringent feed quality evaluation. Heavy metals concentration Pb was obviously below safety level.

D. Improvement and evaluation of feeding management

Feeding experiments on cattle as well as evaluation of OPF feeding management system using OPF-cube based complete diet need to be satisfactory completed.

During F/U Project, OPF based feeds to be used for animal feeding experiment were simultaneously produced while modification works of the processing machinery were carried out. Although OPF 100% feed production was the targeted in the previous 5-year project, value added so-called OPF Total Mixed complete feed was mainly produced and utilized for the feeding experiment of both beef and dairy cattle. The feeding experiments were conducted in large-scale private farms especially in beef animals as well as the constitutional levels.

E. Economic evaluation of OPF production (MARDI only)

Viability of OPF plant should be further investigated by MARDI.

Field of economic evaluation was handled and performed as a separate and special activity of C/P of MARDI. The cost of OPF material and drying are among structural components of production cost and as such were figured out as the main factor to increase production cost. Therefore, development of cost-reduced technology was targeted in the field of development of OPF feed processing technology.

2) Necessary inputs (finance, personnel and equipment) have to be provided adequately by both Japanese and Malaysian governments to ensure the achievement of the Project purpose in case that the follow-up for the Project is implemented.

Input from Japanese side is as follows.
Long-term expert: Chief advisor, Agro-machinery, and Project coordinator.
Short-term experts: Five (5) were dispatched when as needed.
Number of C/P training in Japan: Four (4) in 1st year of F/U and Six (6) in 2nd year.
Supply of equipment: OPF Harvesting/collection machinery costed about 17million Japanese Yen and modification of the processing plant costed 15 million Japanese Yen.

Input from Malaysian side is as follows:
Allocation of C/Ps: Thirty-five (35) in number.
Allocation budget: Management cost and operation of the processing plant, amounting about

RM400,000.

3) Market competitiveness of OPF feed in terms of price is vital for a wide dissemination of the OPF feed technology and user's confidence, which is mentioned as the verifiable indicator of the Project purpose in the PDM. More activities are needed to reduce the production cost of the OPF feed in the following fields.

A. To develop the low cost harvesting and handling system for large amount of OPF in oil palm fields.

During the previous 5-year project, development of system of manual operation and medium-sized machinery was enhanced for OPF material harvesting/collection. However, it was pointed out that the system would be costly due to the following reasons:

a. **The system was not suited with the initial designed capacity of OPF feed processing plan,**
b. **The technology was not suitable to large-scale oil palm plantation in Malaysia, and**
c. **Manual operation had to handle specific and handy of material with 7 to 8 m length and 15 to 18 kg of weight.**

As for F/U Project, a self-propelled OPF harvester, having the following performances, was developed;

a. **The machine can pickup OPF layed down in oil palm plantation while it moves,**
b. **The machine can feed the OPF into a cutter unit for chipping at the same time,**
c. **Chipped OPF can be straightly delivered into wagon of the harvester, and**
d. **The chipped OPF can be unloaded onto the lorry when the wagon is full of chipped OPF.**

The machine has already been developed fully and its rate of work is equivalent to 30 man-hours. The technology can markedly reduce the cost of harvesting/collection of OPF.

B. To establish an efficient solar drying technology of OPF for safe drying of shredded OPF.

An original solar drying facility made is in Japan normally used to dry animal waste to make compost at slow pace. About 7 to 10 days were required to dry 2 tons of fresh OPF by use of the solar drying facility in the 5-year project.

Although this solar drying facility was utilized in the F/U project, the operation method of the facility and agitator were as drastically modified heavily and finally the solar drying technology was very much improved as compared with the previous one, especially in terms of efficiency and period of drying.

As for solar drying house, the following modification was done;

a. **A closed type house was changed into an open-air type house based on the analysis of temperature distribution in the house, and**
b. **Hot ventilation wind was generated throughout the solar drying house by use of 45 degree-slanted fans suspended from the ceiling.**

Moreover, the agitator was also modified as mentioned below;

a. **The agitator was equipped with additionally function to stir accumulated OPF on the drying floor up into air by use of up-cut rotation,**
b. **The OPF has much time to meet air (air-OPF exposure time) for drying, and**
c. **Automatic agitation technology was developed to get rid of the accumulated OPF which was naturally formed at both end of drying yards because of up-cut rotation for both forward and backward operations.**

As a result of those modifications, 6 tons of fresh OPF could be dried within 3 days and the cost of solar drying was very much reduced. Apart from reducing time of drying, the quality of dried material were maintained.

C. To establish performance characteristics of the various aspects of the OPF operation system in order to attain steady and continuous flow to achieve maximum/optimum capacity and minimum operation cost.

Almost all problems occurred during the processing operation in the processing plant are attributed to the physical characteristics of OPF, i.e., fibrous, light bulk density and high angle of repose. The original design seemed not considering at those physical properties of chopped OPF. As the result, the material is commonly stuck at certain places such as junctions between conveying equipments, conical part of control tanks, and other locations. Therefore, the processing operation in the plant could not be continuously implemented as planned.

Modification works on certain machinery in the plant have been conducted to obtain smooth flow of both material and final products. Summary of the modification works are as follows:

(1) Feed Hopper (S1)

Feed hopper was supposed to supply dried material to processing line at a fixed flow rate. However the hopper could not smoothly supply the material if it is full of material. During the 5-year project, a screw conveyer was installed on the floor of the hopper; however, the operation was not possible. A slat conveyer was then equipped but it could not discharge OPF at a constant rate. Consequently, manual feeding was performed from time to time.

In F/U Project, the flowing modification works were carried out;

a. **Instillation of lower gear reduction unit,**

b. Placement of five reels was readjusted, and

c. Additions of four our inspection windows.

The length of feed conveyer S2-1 was reduced because clogging occurred at the junction between the conveyer and next vertical bucket conveyer S2-2 (please refer to the processing flow). Rejecting rotating nylon brush was also installed on the conveyer S2-1 to push back the over flown material discharged from the feeding hopper to control the flow amount.

Consequently, raw material supply is smooth and only an operator is required to control the speed of feeding from the hopper, thus, much labor can be saved.

(2) Shifter by-pass for milled material sieving

Dried OPF is milled into small pieces by a hammer mill and fed into a shifter where unground material is separated. The shifter which is located at the 2nd floor of the plant caused vibration and dust is the factor. The hammer mill has been effective in producing uniform ground materials. Therefore, the shifter was demolished and a new square chute was installed.

(3) OPF Mixing Hopper (C5)

This hopper was supposed to store the OPF temporarily before discharging it to screw conveyer leading to mixing line. The shape of the tank was definitely for grains such as soybean, corn and others. Because of conical part of the hopper, the material could not be pushed down even though horizontal pedals were installed in the hopper. Therefore, inner strait wall was installed and vertical pedals were newly fabricated to properly push the material down.

(4) Scale hopper

Scale hopper is installed in the mixing line to weigh material with high accuracy. The scale hopper also had a conical part at the bottom was OPF usually stuck, so that weighing operation had to be sometime stopped. Stainless inner strait wall was also installed; consequently, the OPF can flow smoothly after weighing.

(5) Buffer Bin

In the case of conveying work by belt conveyers, another conveyer is used to change direction of material flow. This tank has a function to hand over the material from a conveyer to another conveyer. Conical part of the tank also hindered the flow of the OPF and sometime the flow stopped. Finally, stainless inner wall was also added to the buffer bin to obtain smooth flow of material.

(6) Product Hopper (G2)

Product hopper is to temporary store the final products and meters the products into weighing scale for packaging. Discharge section was equipped with shutter activated by air cylinder that was suitable for grains but not suitable to cube and pellet. Therefore, cube was especially stuck at discharge unit of products hopper. Conical part of the discharge unit was

removed and new discharging system was added. The system is mainly composed of two metal conveyer located at the bottom of hopper and lateral rubber conveyer to convey the products and drop into weighing and packing machines. As a result, only one operator is required to discharge and pack the products although two labors were needed to operate such work before the modification. In addition to that, observation window was installed to check up inside the hopper so that an operator can check inside the hopper when clogging happens.

(7) Demolishing air duct facility under solar drying floor

Initially, solar drying house had the following problems;

a. **Solar Forced hot air generated by furnace of fossil fuel was used to go through mesh facilitated as the drying floor. However, the hot air only passed partially causing uneven drying of OPF,**
b. **The small particle of the chipped OPF passed through the mesh resulting in material loss.**
c. **The mesh of drying floor was compressed by lorry when the chipped OPF was unloaded, and**
d. **Rainwater penetrated into the pit of drying floor causing bad odor from fermented OPF, due to improper design and fundamental works.**

As development of solar drying technology proceeded, the pit of drying floor was closed and the surface of the floor became frat by putting concrete into the pit. Eventually, unloading work of the OPF on the drying yard and agitation during drying operation could be done smoothly.

(8) Conveying equipment from solar drying house

One end of a conveyer from solar drying house is located under the ground level to transport the material to next slanting conveyer. The pit at the junction of two conveyers is damaged by penetrating rainwater due to mal-design and improper installation work. As a matter of fact, the one end of the conveyer rusted 3 years after the installation.

Those rusted parts were replaced with new ones and water pump with mechanical level switch sensor was provided in the pit of conveyer junction to drain rainwater.

(9) Replacement of slanting conveyer

Solar dried OPF is supposed to be conveyed by a slanting conveyer; however, the OPF slips on the conveyer because the surface of the conveyer is smooth and the conveyer's angle is more than 30 degree. Therefore, the conveyer was replaced with a new conveyer with lag and then the OPF does not slip on the new conveyer.

4) Malaysian side should ensure sufficient budget allocation, proper organizational structure and the assignment of adequate personnel for the development of the technology and required facilities,

including the plant equipment installed through the Project, within and after the term of the Project.

The Budget for the above mentioned modification works of solar drying facilities and the processing plant was born by JICA side because those problems were caused by the original design and implementation work.

As for the Malaysian side, it provided expenses for replacing spare-parts for wearing, repairing work on machine breakdown due to mal-operation, regular maintenance of processing machinery, procurement of fresh OPF, electricity, fuel, and so forth. Malaysian side will provide sufficient budget allocation and adequate personnel to ensure the smooth running of the project.

5) Both sides should give the best efforts to carry on with the remaining activities, such as mechanization of material supply, modification of the plant system and efficient feeding management for cattle as much as possible before the commencement of the follow-up for the Project.

JICA side made much more effort for mechanization of material supply and modification of OPF feed processing plant. On the other hand, Malaysian side emphasized more on the development of efficient animal feed management technology. The feed and feeding management technology is particularly important for the transfer of technology to various target groups as have been planned by the project and MARDI.

6) It is also favorably note of that almost all of the counterparts who received training in Japan are still working for MARDI. Malaysian side should take necessary measures to retain the counterparts continuously even after the termination of the Project.

Five (5) more C/Ps were participated to the F/U Project; therefore, total number of C/P is thirty-five (35) from original 5-year project. C/P on material supply (Mr. Hamdan Manaf) passed away at the beginning of F/U Project and a new C/P was allocated from the Mechanization and Automation Research Centre of MARDI. Malaysian side will try to retain all counterparts in the project even after the termination of the project

7) The Means of verification in the PDM should be determined to indicate concrete and accurate accomplishment of the Project by the beginning of March 2002.

Activity of project is based on the Project Design Matrix (PDM) of F/U Project that was

Annex 6 Others Number of Enquiries on OPF feeds

MARDI has received about 60 enquires from institutions and private companies for OPF feeds. Unfortunately, official records are not kept for those enquires, however, 13 organizations listed in table 1 requested MARDI to produce OPF feeds and samples were sent to them. Out of 13 organizations, OPF feeds have been delivered to 3 organizations as indicated in table 2.

Companies requested OPF feeds* Table 1

	Name of Companies	Livestock	Requested Amount
Domestic			
1	Rubber Industry Smallholders Development Authority (RISDA)	Goat	30–50 t/month
2	Espek (Subsidary of RISDA)	Beef Cattle	10 t/month
3	Federal Land Development Authority (FELDA)	Beef Cattle	20–40 t/ month
4	Majid Farm, Terengganu	Goat	10–20 t/ month
5	Johore Tenggara Oil Palm Plantation (JTOP)	Beef Cattle	50 t/month
6	Federal Flour Mill	Goat	50–60 t/ month
7	Wetland	Dairy Cattle	15–20 t/ month
8	Yayasan Pelajaran Johor (YPJ)	Beef Cattle	20–30 t/ month
9	Service Trend farm Consulting (M) Sdn. Bhd	Horse	5–10 t/ month
10	University of Malaya	Goat	10 t/ month
Overseas			
11	TOMEN (Japan)	100 % OPF	6000 t/ year
12	Tsang Yung (Korea)	101 % OPF	5000 t/ year
13	Middle East	Miscellaneous	2000 t/ year

* Cumulative request through various channels

Companies whose request for MARDI OPF feeds were met Table 2

	Name of Company	Livestock	Amount of Supply	Duration of Supply	Remarks
1	Rubber Industry Smallholders Development Association Sdn. (RISDA)	Goat	20–30 t/month	6 months so far, On going	Cost of Material is covered by RISDA
2	Johore Tenggara Oil Palm Plantation (JTOP)	Beef Cattle	5–10 t/month	6 months X 2 times	Experiment
3	Yayasan Pelajaran Johor (YPJ)	Beef Cattle	10–15 t/ month	6 months	Experiment

Fact of RISDA Smallholders Plantation Sdn. Bhd (RSPSB), Kuala Lumpur

As of Dec 2003

Location	Kampung Awah, Temerloh, Pahang, Peninsular Malaysia
Total goat breeding centre	3
Species	Boer goats and its crosses
Total number of rams	Dec 2003: 63; 2004: 88; Targeted 2005: 100
Total number of females	Dec 2003: 5,000; 2004: 7,000; 2005: 8,000
Production system	Intensive feeding (feedlot). Lambs of 3 months of age will undergo "contract farming (5 smallholders / 150 lambs). RSPSB will by-back when the animals reach 9 months of age
Feeding regimen	50 % grass: 50 % OPF-based pellet

Economic Analysis of Feeding on Goats

Group	Sex	Initial live-weigh (kg)	Live-weight gain (kg)	Total cost	Feed/wgt cost (RM)
1 (Grass:Corn:Soyahull) (80:10:10)	Male	18.80	87.50	35.70	3.64
	Female	17.30	85.71	26.38	2.75
	Mean	**18.05**	**86.61**	**31.50**	**3.25**
2 (Grass: OPF complete pellet 50:50)	Male	20.0	134.82	52.01	3.44
	Female	18.40	83.04	41.97	4.51
	Mean	**19.20**	**112.50**	**47.50**	**3.77**
3 (Grass: PKC) (50:50)	Male	18.40	35.71	25.79	6.45
	Female	17.20	18.75	20.47	9.75
	Mean	**17.80**	**28.57**	**23.42**	**7.32**
4 OPF complete pellet (100 %)	Male	19.80	209.82	94.50	4.02
	Female	19.30	147.32	66.63	4.04
	Mean	**19.55**	**167.41**	**75.94**	**4.05**

OPF pellet: Complete, containing 30 % OPF
Breed: Boer X Cashmere (20 male and 16 females)
Age: 6 – 7 months
Feeding period: 112 days
Feeding system: Feedlots
Location: RISDA Kampung Awah, Pahang.

Fact of JTOP and YPJ As at September 2003

	JTOP	YPJ
Total area of estate (ha)	1,900	
No. of estate	12	
No. of oil mill	2	
Area of cut grass (ha)		5
Beef production method	Grazing (Open pasture)	Grazing (Open pasture)
	Integration	Integration
	Feedlot	
No. of cattle (head)	3,153	1,328
Targeted No. of cattle	7,000	
Species of cattle	KK (90%)	KK cross
	KK cross (5%)	
	Brahman (5%)	
Sales amount (head/year	260 (Male)	
	70 (Female)	
Sales price (RM/head)	1,500 (Male)	
	900 (Female)	
Annual total sales	453,000	285,090

Advantages of OPF-Based Feeds To Beef and Dairy Farmers / Industry in Malaysia

Beef

- OPF- based feeds is superior than grass or PKC alone. Collection of grass is no longer necessary.
- Provide a complete feed which can allow a growth rate of between 700 – 1,200 g/day (depending on the age, stage of growth, dietary formulation and previous nutritional status)
- Feeding time is markedly reduced by about 30 %
- Cost of production is further improved by 30 %
- Good carcass quality based on rib-eye area.

Parameter	OPF Feed (Cube)	Control Feed (PKC+Grass)
Growth Rate		
-Initial BW (Kg)	196.3	191.7
-Final BW (Kg)	319.8	223.9
-BW gain (Kg)	123.5	32.2
-Average Daily Gain (ADG)	0.93	0.24
-% Increase in ADG (from Control)	287	-
Feeding Period		
Acceptable Starting BW (Kg) Acceptable	200	200
Marketable BW (Kg)	320	320
-ADG	0.93	0.24
-Feeding Period (Days Fattening)	129	500
Saving in Feeding Period (Days)	321	-
Productivity		
-Feeding Period (Days)	129	500
-No. of Marketable Animal in 500 days	3.9	1
-% Increase in Productivity	390	-

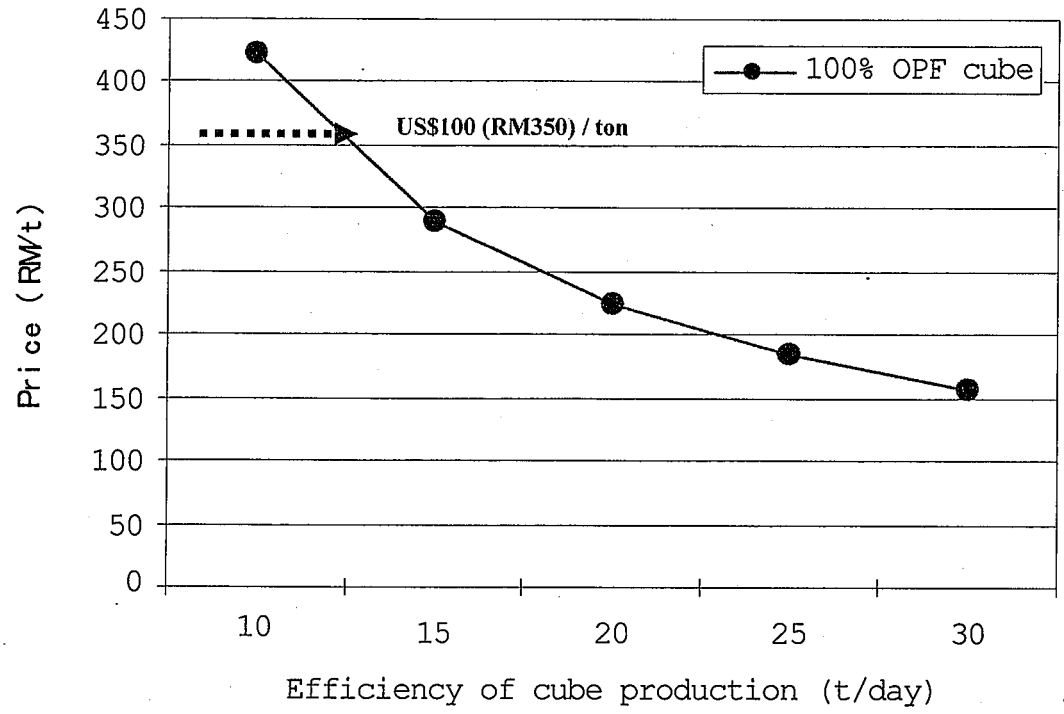
Dairy

- OPF- based feeds is superior than grass or PKC alone. Collection of grass is no longer necessary.
- Can maintain milk production of up to 20 liter per day / animal (based on 1 experiment held at the institutional level
- Feeding time is markedly reduced.

Advantage of OPF based feed in costing

According to Project publication No. 26, simulated production cost of OPF TM cube and 100% OPF cube depends on production capacity of processing system and the cost of 100% cube especially reduces as the capacity increases. As shown figure below, the cost of 100% OPF cube is quite competitive against internationally traded price of animal feed, US$ 100.00 per ton, equivalent to RM350.00.

Figure: Simulated OPF feed cost



Approach to a model plant of OPF feed

1. Modeling factors & conditions

Product : OPF-TM-Cube

Formation : OPF 30%

Set up place : In an oil palm plantation

Plant operation hour : Day time

Working system of harvesting and transportation : One harvester + one lorry

2. Machinery performance of harvesting and transportation

Performance of the OPF harvester : not less than 4 mt/h

Loading capacity of the lorry : 1 mt

Performance of transportation by the lorry : 15 minute / shuttle

(including loading & unloading, average hauling distance ; 2km x 2 = 4km)

3.Determination of model

3-1. Determination of production scale

Harvesting raw OPF per day : ----------4 mt/hr(MC,65%) x 5-6hr/day = 20 - 24 mt /day

(Ave. 22 mt/day)

Raw OPF of 22 mt (MC,65%) = Dried OPF of 9 mt (MC,15%)

Dried OPF of 9 mt ---------- OPF-TM-Cube almost 30 mt (OPF Formation 30%)

Processing amount of OPF-TM-Cube per day ----------30 mt/day

OPF-TM-Cube (30%OPF) processing capacity of the Plant : 30mt / 6 hour = 5 mt/hr

Amount of OPF-TM-Cube /year/Plant : 30mt x 250days = 7,500 mt/year/Plant

3-2 .Determination of covering area

Amount of dried OPF/year/Plant: 9 mt x 250days = 2,250mt/year/Plant

Yield of OPF/ha: 24,480kg(Fresh) or 10 mt /ha/year (M.C. 15%)

Area of Oil Palm Field to supply 2,250mt of OPF ---- 2,250 mt / 10 mt = 225ha

225 ha = 1.5km x 1.5km

(Distance of transportation : within 2km)

3-3. Determination of No. of cattle to be feed

Intake of OPF feed / day. head: 3kg (M.C. 15%)

Intake of OPF feed / year. head : 3kg x 365days = 1,095kg

2,250 mt / 1,095kg = almost 2,000 heads of cattle