

EX-POST EVALUATION STUDY
ON
PROJECT FOR DEVELOPMENT OF TECHNOLOGY
RELATED TO THE PROCESSING OF FEED
BASED ON AGRO-INDUSTRIAL BY-PRODUCTS OF
OIL PALMS IN MALAYSIA

FINAL REPORT

MARCH 2007

JAPAN INTERNATIONAL COOPERATION AGENCY

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1.0 Background

The Malaysian Government made a formal request to the Japanese Government in October 1994 for technical assistance on the research and development of livestock feed using the agro-based by products of oil palm fronds. The Government of Japan, through Japan International Cooperation Agency (JICA) provided the Project-Type technical cooperation from March 1997 to March 2002 for a period of 5 years. A total of 32 long and short-term technical experts were dispatched to MARDI, the Malaysian counterpart agency for this project, for various periods of stay in Malaysia. During this technical cooperation period, the experts carried out research and development work jointly with the Malaysian counterpart engineers and food scientists at MARDI., using various inputs from both governments, which included equipment, machinery, land and building. A pilot plant was set up for development of the feed using oil palm fronds at MARDI headquarters in Serdang in the State of Selangor, about 35 km south of Kuala Lumpur.

Due to some delay in the installation of the equipment for the pilot plant in Serdang, the technical assistance provided by JICA was consequently extended for another two years, to March 2004, based on recommendations of a post-evaluation team sent by JICA in October 2001.

During this 'Follow-up' period, a further 9 short and long-term technical experts were dispatched to Malaysia. Additional inputs were also provided by both the Japanese and Malaysian governments. The pilot plant for the OPF (oil palm frond) feeds was completed with refinements and verification to the manufacturing process, in particularly the drying of shredded fronds using solar energy and overall plant management. The feeds manufactured by the Pilot Plant was used to carry out feed management at livestock experimental stations. Results of such experiments were very encouraging. Another post- evaluation team was dispatched in December 2003 to evaluate on the performance of the project.

Three years has lapsed since the completion of the technical cooperation project in March 2004. Japan International Cooperation Agency wishes to verify the impacts and sustainability of this Project. The aim of this Ex-Post Evaluation Study is to thus to reveal the various positive and negative impacts of the Project since 2004 and to examine its sustainability and other subsequent performances of the Project. The results of this Ex-Post Evaluation shall contribute to better-informed decision making in future JICA projects and encourage great accountability. Any lessons learned from the cooperative Project shall also be beneficial to both MARDI and JICA.

2.0 Objectives of the Study

The objectives of this evaluation study are:

- (1) To verify the impacts and sustainability of the Project,
- (2) To reveal the various positive and negative impacts of the Project since 2004 and to examine its sustainability and other subsequent performances of the Project,
- (3) To make recommendations to contribute to decision making in future JICA projects.

3.0 Scope of the Study

The scope of this Ex-Post Evaluation Study includes the review of the previous two post-evaluation reports dated October, 2001 and December, 2003. At the same time, the Consultants paid three visits to MARDI headquarters in Serdang on the 12th and 16th of April 2007.

During such time, the Consultants met with the Director for the Department of Livestock Feed Research, the Pilot Plant Operation Manager, the OPF Project manager as well as the Manager from FELDA (Federal Land Development Authority) who is currently undergoing training at MARDI under its Incubator Program for the OPF Project. The Consultants were able to carry out interviews with these persons in charge of the OPF project and pilot plant during the two visits. Records of these interviews are appended in this Report.

During the visit on the 16th of April, the Consultants were given a guided tour of the pilot plant in MARDI at Serdang. The manager explained the manufacturing process to the Consultants with specific details on the work required, precautions to be taken, manpower required at each of the steps.



Photo 1: The JICA-MARDI OPF Feed Pilot Plant at MARDI HQ in Serdang, Selangor

4.0 Project Performance and Previous Evaluation Results

4.1 Development of Technology Related to the Processing of Feed Based on Agro-Industrial by-products of Oil Palms in Malaysia, 1997-2002

Malaysia has a rather low rate of livestock self-sufficiency (only 20% in livestock meat and 5% dairy in 1997). The overall goal of the Project is to increase livestock production in Malaysia through a stable supply of quality livestock feed using agro-industrial by-products from the large oil palm industry in the country.

The project thus involves the harvesting and transport of oil palm fronds to be processed into livestock feeds. The fronds have to be shredded (suitable size reduction) and its moisture contents reduced by an economical drying process. The raw material is then to be mixed with other ingredients (such as rice bran, PKC, tapioca waste, etc) using a predetermined formula and the final product processed into pellet or cube forms suitable for ingestion by cattle or sheep/goat.

The research and development of this OPF Feed thus involve experiments in arriving at :

- (a) the right size of oil palm frond shredding machine,
- (b) the right moisture contents of the frond material,
- (c) the optimal mix or composition of feed in terms of nutritional and chemical mix; and finally
- (d) the right pellet size for the animals.

The manufacturing process also involves the need to achieve:

- (a) the most economical and efficient manner of harvesting and pre-treatment of the palm oil fronds,
- (b) the most economical and efficient manner in transporting the fronds to the factory,
- (c) the stable supply of frond materials for the factory, which involve selecting fronds from palms that are 5 years or older only to obtain the optimal fiber contents,
- (d) the output volume sufficient to meet the demand.

Finally, the project also involves feeding experiments on cattle and sheep using the OPF feeds produced at the R/D plant in MARDI. This involved the need for:

- (a) experimental feeding plan in both dairy and beef cattle
- (b) conducting feeding experiments for cattle in different environment such as feed lot against open farms,
- (c) evaluation of the performance of the OPF Feed compared with conventional feed in terms of daily weight gain and milk production volume,
- (d) evaluation of the dairy or beef quality.

The first JICA cooperation project was able to solve many of these issues listed above. Based on the post evaluation study conduct in October 2002, the Project was determined to be highly 'relevant', and produced many positive 'direct' impacts (transfer of technology, research capacity and international recognition of MARDI's R/D projects) and 'potential' impacts (productive use of agro by-products, help preservation of forests, etc) but the following outstanding issues were identified:

- (a) the economic and efficient way of harvesting, transporting and pre-treatment (shredding) was not finalized,
- (b) technology to produce a stable quality of OPF feed was not achieved,
- (c) verification of the feed performance at institutional level only and it has yet to be verified at commercial farm level,
- (d) overall economic performance of the OPF feed compared to conventional feed has not been ascertained,
- (e) delays in the installation of the equipment at the pilot plant has affected the production schedule for feed experiments,

Consequently, the post evaluation team recommended an extension of the project for another two years as a 'follow-up' cooperation project to resolve these issued identified above.

4.2 Follow-Up Technical Cooperation Project 2002-2004

Once the delays to the installation of the pilot plant equipment was resolved, the Project picked up its momentum. Many of the activities planned were able to be conducted on time. Many of the outstanding issues identified previously were largely resolved.

- (a) a more efficient system of harvesting and pre-treatment was identified with the development of an 'automatic harvester' which can 'grip' on the fronds from the ground and transfer it to the shredder and the output gathered in a basket ready to be transported to the factory,
- (b) develop the solar system (OKADA) system to effectively dry the pre-treated frond materials. Subsequently, additional innovative gadgets were added to improve the efficiency of this solar energy drying installation. Industrial fans were added to help circulate the air and thus help to dry the material faster; small arms or 'agitator' were added to 'flip' and 'stir-up' the frond materials to help it dry faster;
- (c) the technology in producing a stable and consistent quality OPF feed was verified and established, (resolving such issues as suitable size shredding, pellet size, moisture contents, feed composition mix for specific animals, etc).
- (d) the experiment on feed planning at livestock experimental stations in Johor produce very good results (impressive and better than other feeds performance in terms of average daily body weight gain and milk production, etc).
- (e) the 5S 'Kaizen' method of management was introduced to the pilot plant, and the capacity of the plant was established at 2 tons/hour.

- (f) positive public interests in the OPF Feeds received from the results of a public exhibition and forum conducted.

At the end of this 'follow-up' cooperative period, another post-evaluation study was conducted. The evaluation study found that the Project was highly 'relevant' and well received and supported by the Malaysian Government. There were also very good level of cooperation and technology transfer and exchanges between the Japanese and Malaysian counterparts. Special achievements were attained on:

- (a) the improvements on the OKADA system using solar energy was able to reduce the moisture contents of the frond material from 65% to 20% within 2-3 days compared to 5 days previously,
- (b) the optimal OPF contents for the complete feed for cattle in pellet form was found to be 30%,
- (c) economic and efficient transport of fronds can be achieved if factory is located within 25 miles radius of the palm oil frond source of supply,

Although many issues have been resolved in the 'follow-up cooperative period' the evaluation team concluded that the following are the outstanding issues that need to be resolved but are within the capacity of MARDI:

- (a) although a systematic and rather efficient manner of harvesting the fronds was identified, the cost of the automatic harvester is still an issue,
- (b) supply of raw material for continuing R/D activity at MARDI is constrained by distance to reliable sources nearby,
- (c) constrains by legal system in Malaysia governing R/D institutions like MARDI on the commercialization activity,
- (d) to implement an incubator program to train interested persons from organizations or enterprises wishing to commercialize the OPF feed.
- (e) to continue the R/D activity at MARDI in improving further the quality of the OPF feed and its performance for beef cattle and sheep, especially on the feeding program and feed management; and to further publicize such results to the public in an effort to encourage commercialization of OPF feed in Malaysia as well as for export.
- (f) to apply for patents on the OPF technology to SIRIM of Malaysia.

5.0 Evaluation Method in this Ex-Post Study and Interview Results

5.1 Methods

The methods used for this ex-post evaluation study are:

- (a) Site visit – visit to the MARDI-JICA pilot plant in MARDI's HQ in Serdang, Selangor

- (b) Interviews with officers in charge and ex-participants of the Project:
 - conduct interviews with the director in charge of the OPF project (Dr.Wan Zahari Mohamed),
 - conduct interviews with the production manager at the Pilot Plant (Mr.Yunus Hussain) and business development officer (Tuan Haji Ibrahim Osman)
 - conduct interviews with trainee under the incubator program at the Pilot Plant in Serdang (Mr.Jamil Md.Yasin from FELDA).

5.2 Interview Results and Findings

The Evaluation Study Team visited MARDI in Serdang on two occasions on the 12th April (interview with Director Dr Wan Zahari Mohamed, Mr.Yunus Hussain and Mr.Haji Ibrahim Osman) and 16th April (Site Visit and interviews with Mr.Yunus Hussain, Mr.Jamil Yasin). Dr.Wan Zahari, Mr.Yunus Hussain and Mr.Haji Ibrahim Osman are all ex-participants of the Project.

The following photos shows the present conditions and continuous activities at the JICA-MARDI pilot plant in Serdang.



Photo 2: The oil palm frond 'auto-harvester' developed by the Project



Photo 3: Interior view of OPF manufacturing plant



Photo 4: The OKADA system with improved flipping mechanism for drying shredded fronds using solar energy.



Photo 5: Dried chips are transferred by conveyor belt to this temporary storage bin before being stored in overhead silos.



Photo 6 : Machinery to produce 100% OPF Cubes.



Photo 7: Mixer for mixing the dried OPF chips with other nutritional components such as rice bran, molasses, tapioca, PKC



Photo 8: Machinery to pelletize the complete feed.



Photo 9: MARDI's workers packing the Complete OPF feed pellets into 40kg bags.



Photo 10: Close up of the complete OPF feed pellets.



Photo 11: MARDI has received several domestic and International new invention awards on the OPF feed after the completion of JICA cooperation project.

The major findings based on the interviews are:

On Achievement of Overall Goal

- (a) The Malaysian government has set a goal of increasing the population of cattle and goat to at least 1.5 million heads by 2010. Currently, the country has only about 250,000 heads of cattle, 450,000 heads of goat and 20,000 heads of dairy cow. The doubling of livestock numbers by 2010 will therefore depend on the success of commercializing the feed through FELDA and other companies. The present self sufficiency level of beef in Malaysia is only 20%. The government has targeted a self sufficient of 21.6% by 2010 and 25% by 2015.

The factor hindering this attainment of this goal is the lack of suitable locally developed feed at present to increase the feed-lot livestock industry. Malaysia currently has 4.4 million hectare of oil palm plantations and MARDI estimated that this will enable the country to produce 34 million ton of OPF-based feed a year. This will be sufficient to meet the domestic demand for increases in livestock production as well as with surplus for export.

On Sustainability:

- (a) The OPF Project is being regarded with high priority and potential by the Ministry of Agriculture and sufficient budget is yearly being allocated for continuing with the R/D works at the MARDI-JICA Pilot Plant. The Pilot Plant is still in operation daily, maintaining at the capacity at 2 ton/hour. The plant is also used for training under the incubation program.
- (b) Activities on the OPF project has increased drastically owing to the increased interests from semi-government institutions like FELDA, RISDA and private sectors. This is owing to MARDI's effort in participating in several domestic and international new invention exhibitions and expositions. MARDI has won several awards from these activities.
- (c) Due to legal constraint, MARDI cannot produce and market livestock feeds to the open market as it is only a research institute. It can only produce the feeds under the R/D project and conduct experiments. It however has planned the commercialization of the OPF feeds through other quasi government agencies like FELDA, RISDA and Tabung Haji, as a first step or show case before the private sector can participate in the Project.
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- (d) FELDA has signed a **'Technology Licensing Agreement'** and **'Incubation Tenancy Agreement'** on 16th of December 2005 with MARDI for the commercialization of the OPF-based feed. FELDA has sent two officers for training for the last 1 ½ years with MARDI on the whole process of producing the

OPF feeds. Upon graduation from this training, MARDI will issue a licensing permit to FELDA on the production and manufacturing of this OPF Feed.

At the same time, FELDA has started to build its first factory since 2006 for manufacturing the OPF-based feed in Bukit Sagu, Kuantan, Pahang. During this period, MARDI has provided technical assistance to FELDA in the plant layout, installation of equipment and plant, selection of machinery, etc. This Factory will also be able to produce both the OPF Complete Feed as well as 100% OPF cubes. Production is due to start by July this year and the plant will have a capacity of producing 5 ton/hour. Once the Bukit Sagu Plant starts its production, FELDA will send another two officers to be trained in MARDI.

The following are pictures of the FELDA Bkt Sagu OPF Plant, courtesy of Mr.Jamil Md Yasin, project manager of FELDA.



Photo 12: The FELDA OPF Plant amid FELDA's oil palm plantation in Bukit Sagu, Kuantan, Pahang. It will be ready by July 2007 with a capacity of 5 ton/hour.



Photo 13: Interior of the FELDA Bkt Sagu OPF Plant. Equipment such as silos and blower are in the process of being installed.



Photo 14: Twelve lanes of OKADA solar energy drying system will be installed here in FELDA's Bkt Sagu OPF Plant.



Photo 15: The OKADA System is being installed and tested out.



Photo 16: Conveyor Belt system being installed at the end of the drying beds for transfer to storage silos.



Photo 17: Silos are being installed at the FELDA Bkt Sagu OPF Plant.

- (e) MARDI has recently (April 2007) signed **another similar incubator training program** with a State Owned Oil Palm company in Sabah (Sawit Kinabalu Farm Products Sdn Bhd.). Negotiations are on going with private company in Sarawak (Sarawak Capital) for a similar program.
- (f) MARDI has also received enquiries on its OPF cubes (100% OPF product) from overseas countries, notably from Taiwan, China, South Korea and Japan. Enquiries on the complete feed are mainly from OIC countries and African countries.
- (g) There are also many interests shown by the private sector feed manufacturers in Malaysia. But so far the obstacles for them to venture into OPF feed on a commercial scales are : (1) still not fully convinced on the performance of the OPF-based feed, (2) frightened by the high initial investment costs, (3) regard the manufacturing process as too time consuming. Several private sector manufacturers have visited MARDI and tried to produce the OPF Feed but using their own improvised steps, notably the drying process by using diesel-powered hot air blowers. The recent increase in fuel cost has put these enterprises into serious troubles. Among these private companies, there is only one that is still quite successful, which is located in Naka in KEDAH. It manages to produce about 100 ton/mth, with a maximum capacity of 400-500 ton/mth.
- (h) The high cost of the automatic harvester and its small capacity are still problems hindering the lowering of cost in raw material supply for the OPF feed. To reduce cost of transportation, distances between source supply to factory must be kept

short (<25 km). Hence the strategic location of factories is a major criteria in planning future commercialization ventures.

On Impacts

Impacts on the National Agriculture Policy

- (a) The potential impact of this project on the national agriculture policy as far as increase in self sufficiency in beef, mutton is concern, will be very significant in years to come. MARDI has estimated a potential production of OPF feed at 34 million ton a year in Malaysia based on the current 4.4 million ha of oil palm plantations in the country.
- (b) When the FELDA program takes off and successful in producing quality OPF Feed and in sufficient quantity to support FELDA's livestock production project, more farmers will surely accept the use of the OPF feed. The beef and dairy self sufficiency rate for Malaysia will improved in the future.

Impacts on Related Industries

- (a) The OPF project is expected to produce some **positive impacts** to the related industries. Small holders and settlers in FELDA schemes are expected to earn some additional income from harvesting their fronds once FELDA starts to produce the OPF Feed on a commercial scale. Out of the 4.4 million ha of oil palm plantation in Malaysia, 60% belong to FELDA. Its potential is very high.
- (b) The good performance so far shown by MARDI's experiment on beef cattle (especially for Brakmas breed of beef cattle which is a cross bred of Indian Brahman cattle with local Malaysian KK breed) is very encouraging and will increase beef production in the country significantly in the near future. RISDA has started its own livestock farming projects and is experimenting with MARDI's OPF complete feed for BOER breed of sheep imported from South Africa. The results so far have been very good.
- (c) The OPF feed project will not adversely impact on other industry such as the up and coming bio-fuel project using oil palm by-products. This is because bio-fuel plant uses by-products from the oil palm fruits which have a higher bio mass production per ha per year compared to oil palm fronds.
- (d) There is no obvious negative or positive impacts on the feed industry at the moment. The current economic cost of production of the OPF Feed is comparable to the cost of conventional feed in the open market. One external factor is the increase in prices of palm kernel cake, which is widely used in other conventional livestock feed. The conventional feed also uses dried grass, whose supply is also affected by the weather, such as draught. OPF supply is rather stable and constant,

considering that Malaysia has 4.4 million hectares of oil palm plantation. The only factor is the manufacturing plant for the OPF feed must be located within 25 km radius of the raw material supply source, to enable the lowering of costs for harvesting and shredding and transportation to the factory.

6.0 Results of Evaluation

6.1 Evaluation Grid

Criteria	Indicators	Sources of Information	Method	Evaluation
A. Impact	1. Possibility of achieving the overall goal	Final evaluation report, interview results	Examine whether the project has helped to achieve the overall goal. Investigate the major factors affecting MARDI in achieving the overall goal.	The overall goal requires longer time period to achieve. MARDI has indicated that the Ministry of Agriculture aims at increasing the beef self sufficiency from the present 20% to 21.6% by 2010 and to 25% by 2015. If FELDA and other large state owned oil palm plantation companies succeed in producing large quantity of OPF Feed, the above targets are achievable.
	2. Impact to oil palm and animal husbandry industries	Final evaluation report, interview results	Examine the kind of positive or negative impacts if any have occurred to the related industries (palm oil, animal husbandry and feed industries) Examine the reactions or feedbacks or opinions of these industries on the use or commercialization of OPF feed. Examine whether MARDI has started or to what extent, implemented the recommended INCUBATOR System of training for private sector participants? Investigate the external or internal factors that affected these impacts?	No obvious negative impact to the related industries. Positive impacts to small holders and FELDA Settlers as they get additional incomes from selling the fronds. MARDI has implemented the incubator system 1 ½ year ago for FELDA. FELDA has construction its first OPF Feed Plant in Bukit Sagu in Kuantan, Pahang with a capacity of 5 ton/hour. Two FELDA officers have been trained for the last 1 ½ year at MARDI. Other similar programs are soon to start for 'Sawit Kinabalu' and 'Sarawak Capital', both state own companies. External factors may work to OPF feed advantage in price competitiveness as conventional feed relies largely on PKC and grass which are easily affected by fuel cost and draught. Supply of frond is more stable. Internal rules and bureaucratic practices in FELDA may work against the achievement stated above.

				<p>Initial investment cost of machinery and plants are high which easily deter private sector or small investors.</p> <p>High cost of automatic harvester is also a negative factor. Plant must be located close to the manufacturing plant (<25km) to keep transport cost to a low level.</p> <p>The complete OPF Feed has 70% of other ingredients, some of which are also imported. To make the OPF feed more competitive, more local by products must be used. (tapioca, rice bran instead of wheat bran and molasses)</p>
	3. Impact on agriculture policy	Final evaluation report	Examine whether the project has produced any impacts on agriculture policy of the government?	The good performance of the OPF feed tested by MARDI on its livestock stations have given the DOA to place importance and priority on the continuation of the R&D project in MARDI. The policy in improving self sufficiency in beef production is being implemented with more confidence.
	4. Impact to institutions (MARDI, DOA)	Final evaluation report, interview results	<p>Examine whether the project has produced any noticeable impact on the organization, research capacity, staff morale, work ethics, etc in MARDI or DOA</p> <p>Investigate whether there are any new research findings and professional publications/papers by MARDI since 2004</p>	<p>The staff at the MARDI-JICA pilot plant is found to be more motivated and they are willing to try harder. Partly, the incentives knowing they have a chance to go for training overseas have helped as well. The 5S Kaizen system is very helpful, but due to the limited manpower, it cannot be practiced to a satisfactory level. Cleaning schedule is only 2 times a month.</p> <p>MARDI has presented its research papers in many occasions and has also participated in domestic and international exhibitions. It has received awards from South Korea and from within Malaysia.</p>
B. Sustainability	1. Capability of research and implementing institutions (DOA, MARDI)	Final evaluation report, interview results	Examine whether the institutes are able to continue with the research, especially on the continuous testing and experiments needed to verify the economic viability of the OPF feeds, and to continue	MARDI is capable to continue with the R&D. Its pilot plant capacity remains at a maximum rate of 2 ton/hour or about 10-12 ton a day. As long as it is involved in R&D activities, the plant and its equipment are still working efficiently.

			<p>improvement on feed quality, etc</p> <p>Examine whether MARDI has identified ways to overcome problems relating to sufficiency and sustainability in raw material supply and transport</p>	<p>MARDI is also working to develop new feed products using OPF for other livestock animals such as BOER sheep and Ostrich.</p> <p>MARDI's plant is dependent on supply from nearby UPM and Putrajaya plantations which are now being developed into urban areas. MARDI has to obtain supply of raw materials further afield, which may incur higher transport costs.</p>
	2. Financial conditions and budget allocation	Final evaluation report, interview results	<p>Examine whether MARDI has continued to receive sufficient financial supports or budgetary allocation from the MINISTRY of AGRICULTURE or Treasury for the continuing research and experiments, maintenance and operation of the pilot plant, and implementing the incubator program.</p>	<p>MARDI has continue to receive sufficient funding from MOA to continue with its R&D activities on the OPF Project.</p> <p>MARDI also receive payment from FELDA for participating in its incubator system. FELDA itself has special funding for the OPF project. Its Bukit Sagu Plant is being developed at a cost of RM15 million with a capacity of 5 ton/hr.</p>
	3. Capability of C/P to continue with the activities	Final evaluation report and site visits	<p>Examine whether the C/P are retained at the institutes and they are capable to handle all equipment, conduct test and experiments, operate and manage the pilot plant, conduct new research, etc</p>	<p>Since the completion of JICA's Cooperation Project, except for a few who have retired, most of the counterpart officers, in particular, key officers Dr.Wan Zahari, Mr.Yunus and Mr Haji Ibrahim are still working actively on the OPF project.</p>
	4. Others		<p>Examine whether any agreement being reached on agreement between Malaysia and JICA, regarding on the use of the R/D technology by third countries?</p>	<p>The application for patents on the OPF technology to SIRIM is still pending.</p> <p>For the transfer of technology to third country, it is too early to consider. MARDI still needs more time to further verify the performance of the OPF Feed, especially from other livestock projects such as FELDA's.</p>

6.2 Recommendations and Lessons learned

The Study concludes that:

- (a) The JICA-MARDI OPF Project is well sustained by policy emphasis and budgetary allocations from the Ministry of Agriculture for its continuing R/D activities. Its commercialization is currently being actively pursued by MARDI through the INCUBATOR PROGRAM with FELDA. FELDA has constructed its first OPF plant in Bkt.Sagu in Pahang and is due to start production by July 2007 with a capacity of 5 ton/hour. Similar projects are being signed with state-owned companies in Sabah and a private enterprise in Sarawak.
- (b) The MARDI-JICA pilot plant is still in active operation in Serdang, maintaining a capacity of 2 ton/hour. It will be used by MARDI as the R/D center on developing livestock feeds as well as the training ground for its OPF INCUBATOR PROGRAM. FELDA officers have been trained here for the last 1 ½ years on the manufacturing of OPF feed.
- (c) The impacts of the OPF Project will be very significant in years to come, when the commercialization on the production of OPF feed takes off by FELDA's Project. Livestock industry will receive a boost if the cost of the OPF can further be lowered by FELDA since it will have a more stable supply of oil palm fronds close by the factory.
- (d) At the same time, small holders and settlers in FELDA plantations will also benefit from additional income either for supplying the fronds or even participating in the manufacturing plant.

Based on the evaluation results, the Study recommends that:

- (a) Expand the incubator program using the Pilot Plant for training of participants. Ensure sufficient personnel in MARDI itself to provide training as well as follow up technical supports to all Incubator Program Participating Companies.
- (b) Examine further the viability of overseas market for 100% OPF cubes.
- (c) To solve the shortage of raw materials to the Pilot Plant by cooperating with small holders nearby, such as sharing the profit from sale of final OPF products, which is another way of publicizing OPF feed to local users; or to work closely with future incubator program participants whereby they would supply the raw materials to the plant during the training period.
- (d) To further improve the automatic harvester in terms of reducing its capital investment cost and higher speed of shredding.

- (e) To encourage routine 5 S management practices at the pilot plant by giving some form of incentives to workers. Transfer this know-how to FELDA's Bkt Sagu Plant.
- (f) Work closely with FELDA to develop a national model of OPF Production and monitoring the outcomes of feed management for livestock farms using the OPF complete feed, thus to further verify the quality of the OPF feed for livestock farming. MARDI can compare results of its own experiments with those from FELDA, hence to further strengthen its data reliability and research results.
- (g) To begin preparing technical guidelines or specification requirements for constructions of OPF plant, in avoiding delays due to civil work incompatibility with equipment or installation requirements (such as experienced by Bukit Sagu FELDA Plant).

The lesson learned from this JICA Cooperation Project are:

- (1) Although the Project is very relevant to Malaysia's agriculture policy, the setting of the project goal at the initial project planning stage should consider carefully the achievability of such goals **within the project period**. The initial overall goal set for this Project is too ambitious and not realistic to be achieved within the short 5-year period.

A technical cooperation project such as this OPF project requires a longer time period to achieve the final goal. This is a R&D pilot project for fine-tuning the technology in producing feed using agro-by products and its manufacturing process. A more reasonable goal should have been set at the beginning of the planning stage of this Project, to be achieved within the short 5 years cooperation period. To attain the final commercialization of the technology and large scale production of the feed for developing the livestock industry in Malaysia requires a much longer time period.

For future projects that are similar in nature to this Project, care must therefore be taken when setting the goals at the planning stage to ensure that such goals are achievable within the cooperation time period.

- (2) During the planning stage, JICA needs to study more carefully the underlying **legal, institutional and operational constraints** of the counterpart agency in future cooperation projects.

In this particular case, MARDI is a R/D institute, which is constrained by Malaysian Law from indulging in commercialization of any research products or technology. MARDI is the ideal choice as the counterpart agency in this Project for fine-tuning and perfecting the feed manufacturing process. But when it comes to commercialization of this newly developed technology, a more suitable agency should have been identified at the beginning of the Project.

Once the technology and manufacturing process has been perfected and the results proven by actual experimentation by MARDI, such agency can then take over the role of marketing such technology either in joint ventures or other forms of commercialization to the private sector. In this manner, it will help to speed up the attainment of the final goal.

- (3) The delays due to poor coordination at the initial implementation stage of this Project could have been easily avoided if there is **better coordination** between Japanese and Malaysian sides in terms of getting ready and supplying the agreed inputs to this Project. (Land and Building by Malaysian Government, equipment by Japanese Government). To achieve smoother coordination and avoiding delays, a more detailed and clearer time frame in construction of buildings and installation of equipment must be prepared.

For similar future projects, JICA and the counterpart agency must take steps to ensure more effective monitoring of the progress in implementation to avoid such unnecessary delays and inefficiency.

Appendix -A: Interview records

Date: 12th April 2007

Interview with Dr.Wan Zahari Mohamed , Mr.Yunus Hussain, Mr.Haji.Ibrahim Osman;
by: Mr.Chua and Aishah (IC Network Sdn Bhd.)
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Achievement of Overall Goal

- 1. The Ministry of Agriculture has set a target of doubling the production of beef and dairy products for domestic consumption by 2010. In what way has the JICA project helps to achieve this overall goal?**

The Malaysian government has set a goal of increasing the population of cattle, goat to at least 1.5 million heads by 2010. Currently, the country has only about 250,000 heads of cattle, 450,000 heads of goat and 20,000 heads of dairy cow. The present self sufficiency level of beef in Malaysia is only 20%. The government has targeted a self sufficient of 21.6% by 2010 and 25% by 2015. These targets are achievable provided we have developed enough feeds for them. Many animal farms are ready to import more cattle or sheep and goats from overseas, but they need a steady supply of feeds. If we can solved the supply of feed, these targets are definitely achievable, and maybe even earlier than the target dates.

- 2. Assessing the progress of the R/D project at this point in time, is this goal still achievable by 2010?**

Yes.

Of course the R/D project in MARDI on the OPF feed is still on going, as we are continuously trying to improve the quality of the feed, finding ways to reduce the production cost, resolve the supply and transport problems of the frond, developing the incubation training program, answering enquiries from interested groups/persons, and experimenting new formulae of OPF Complete feed mix to suit different requirements, such as for horses, ostrich birds, boer goats from Africa.

- 3. Is the production of OPF feed on a commercial scale still considered viable by MARDI?**

Yes. Definitely.

4. Has MARDI started to plan for the commercialization of the OPF feed?

MARDI by law cannot produce and market animal feeds to the open market. It is only a research institute. It can only produce the feeds under the R/D project and conduct experiments.

MARDI however has planned the commercialization of the OPF feeds through other quasi government agencies like FELDA, RISDA and Tabung Haji, at least as the first step or show cases before the private sector can join in. FELDA has already started to participate in our Incubation program by sending two persons for training for 1.5 years with MARDI on the whole process of producing the OPF feeds. Upon graduation from this training, MARDI will issue a licensing permit to FELDA on the production and manufacturing of this OPF Feed. FELDA has started to build its factory in manufacturing the OPF Complete Feed (OPF feed containing 30% OPF and the rest by rice bran, molasses, palm kernel cake, etc) in Bukit Sagu, Kuantan, Pahang. MARDI has provided technical assistance to FELDA in the installation of equipment and plant, selection of machinery, etc. Production is due to start by July this year and the plant will have a capacity of producing 5 ton/hour.

5. What are the steps taken by MARDI regarding the economic viability of the production of OPF feed?

MARDI since its development stage with JICA on the OPF feed has continuously trying to reduce the cost of production of the OPF feeds. MARDI has so far developed two types of feeds. One is the 100% OPF (100% palm fronds) which contain more than 60% fiber, 5% protein and is in cube form. The other is OPF complete feed, which is a mix of OPF and other components (such as rice bran, salt, molasses, palm kernel cake, urea, vitamin, palm oil) and is in pellet form. Depending on the type of animals the complete feed is meant for, the formula for such mix may differ. For beef cattle, for example, MARDI has found through experiments and testings, that a mix of 30% OPF, 70% other ingredients work best. The 100% OPF is thus no suitable for beef cattle as they require at least 16% protein contents.

Traditional feed for cattle in the country is often a random mix (by individual supplier) of palm kernel cake, dried grass, and others. The present price of OPF complete feed developed by MARDI for beef cattle is about RM350/ton and for dairy cow is RM650/ton. These prices are comparable to the conventional feeds, but with the OPF complete feed being so much better in nutritional values, the viability of the OPF feeds being accepted by the farmers is definitely yes.

We have also found that the OPF feed contains a special substance that impede the growth of fungus. Feeds we produced several years ago, are still in good conditions, without any degradation of its contents and best of all, never get mouldy. (Mr. Yunus)

6. What are the major obstacles for MARDI to achieve the overall goal and the commercialization of the OPF Feed?

The major obstacles are (1) many farmers in Malaysia always have the 'wait and see' attitude, (2) frighten by the high initial costs by potential feed manufacturers, (3) wanting to cut short the steps in the production process.

There are no shortage of enquiries from the private sector on manufacturing this MARDI-JICA developed OPF Feed, but they often backed away from the investment costs or rather skeptical about the results. But after we have supplied the feeds manufactured here in MARDI to FELDA and RISDA and received very good response and feedback, they are now confident about the benefits of this feed. RISDA has used MARDI manufactured feed for the BOER GOAT Farm in Kampung Awah, Pahang.

There were in fact three private manufacturers who came to visit us and obtain information on the production process, taken pictures of the pilot plant, etc and started their production line. However, they underestimated the difficulty we experienced here in MARDI over the last 5 years trying to perfect the process. They wanted to cut corners and use other quick methods of drying, for example, by using diesel to heat up and dry the shredded fronds and with the increases in fuel prices, they have become not viable.

Impacts on the Related Industries

7. What sorts of positive or negative impacts have occurred to the palm oil and animal farming industries as a result of the OPF Project?

There is no negative impacts on the related industries. In fact there are many positive impacts on these industries. For instance, during our initial development stage, we obtain the OPF free of charge from the plantation belonging to UPM. Now that this plantation is no longer there, we have to source our raw materials from nearby plantation. Initially we were still able to get them free, but now that many plantation owners knew about our OPF Feeds, they demanded payment for these fronds. It is a cost to us, but an income for them. The good results of OPF Feed tried out by FELDA and RISDA have produced very good impact on the animal farming. As more and more farmers came to know the performance of the OPF Feed, it will be a huge positive impact in terms of helping farmers to increase income and increase the self sufficiency level in the country.

8. Have the results of the pilot experimental testing of OPF being widely publicized to both industries?

We received many and countless enquiries, and some from overseas as well. China has recently send a team to visit us and they came to know our OPF Feed. China, Korea, Japan, Taiwan all needed fiber rich feed to supplement their own feed production. China wanted something like 40,000 ton a year supply which of course we cannot meet at this moment.

We have received new invention awards, after the JICA cooperation has ended, from within Malaysia as well as KOREA Invention Association. This reflects the wide publicity or knowledge of our OPF Feeds both within Malaysia and overseas..

There are also enquiries from African and Middle Eastern (OIC) countries on our OPF Feeds. For these countries, they require the OPF complete feed in pellet form.

We estimated that demand from overseas is in the region of 200,000 tons/year.

Within Malaysia, we have received proposals for transfer of technology notably from FELDA, RISDA, Tabung Haji, Sabah Global, Sawit Kinabalu, Sarawak Capital on the OPF Feeds. In fact we have just inked the MOU on the transfer of technology with Sawit Kinabalu on the 10th April, two days ago. We also received many keen interests from the State Governments of Perak, Selangor and Trengganu.

9. If Yes to the above question, what kind of feedback has MARDI received from them?

Feedback we received from the private sector which has tried our feed is very good. Milk production for instance, has increased to 15-20 liters / day compared to 8-10 liters/day by conventional feed, beef production increased to 0.5-0.8 kg/day compared to 0.3 kg /day previously, and mutton (goat) to 170-180 g/day compared to 80-100g/day before.

10. Has the JICA's OPF project produce any positive or negative impacts on the feed industry in the country?

The project has not produce any negative impact on the feed industry. So far, production of OPF feed is still limited. Until FELDA and RISDA can produce sufficient quantity to supply the market demand, the feed industry will get a boost by then. Among the private companies, there is one that is still quite successful located in Naka in KEDAH, whose factory now produces about 100 ton/mth, with a maximum capacity of 400-500 ton/mth.

11. Has MARDI started or to what extent implemented the recommended INCUBATOR System of providing training on the use and manufacturing of OPF to private sector at the pilot plant?

Yes. The incubator system has already started one and the half years ago. We received special funding from the Treasury for this program. So far we have trained two persons from FELDA, teaching them from A to Z on the production process of the OPF Complete feed. We have make sure they know how to operate the machine, trouble shoot and have actually produce 2 tons of feed here by themselves to achieve their confidence. They will soon graduate from MARDI and man the plant that is under construction in Bukit Sagu in Kuantan. This particular plant is planned to start production of the OPF Feed by July this year. FELDA is going to send in 2 more person for training and Sawit Kinabalu will also send in 2 persons for training soon. (Mr.Haji Ibrahim)

Once the FELDA plant has attained stable production of quality feed, we might even license the FELDA Plant to become a qualified training centre, so that they can in turn provide training to other interested parties.

12. What are the internal or external factors that have either help or hinder the progress of the OPF Project?

One external factor is the increase in prices of palm kernel cake, which is widely used in other conventional animal feed. The conventional feed also uses dried grass, whose supply is also affected by the weather, such as draught. OPF supply is rather stable and constant, considering that Malaysia has 4.4 million hectares of oil palm plantation. The only catch is the manufacturing plant for the OPF feed must be located within 25 km radius of the raw material supply source, to enable the lowering of costs for harvesting and shredding and transportation to the factory. To this, MARDI is promoting the setting up and widely scattered location of manufacturing plants of OPF feed among the various states.

Impact on National Agriculture Policy

13. What impact has the JICA's OPF project produce regarding Malaysia's Agriculture Policy at the national level?

The potential impact of this project on the national agriculture policy as far as increased in self sufficiency in beef, mutton is concern, will be very significant in years to come. Malaysia now has 4.4 million ha of oil palm plantations and we estimated that this will enable us to produce 34 million ton of OPF Feed a year. This will be sufficient to meet the domestic demand as well as with surplus for export.

Impact on MARDI and DOA

14. Are there any noticeable impacts by the JICA project on the research capacity, organization, staff morale, working ethics, teamwork, etc in MARDI or DOA?

To some extent, especially with the prospect of receiving training in Japan and other overseas countries, workers involved in this project are more motivated to try harder.

15. Is the 5S Kaizen system of management still being practiced for the pilot plant? Has this management technique being extended to other areas within MARDI or DOA?

We have reduce the workers number from the initial 10-15 workers to the present 3 workers. They are preoccupied with the production and thus we find it hard to require them to routinely implement the 5S system. Moreover, the nature of the production is such that the environment will always be dusty. We implement regular cleaning schedule at once every two weeks. We find it hard to extend such system to other departments or units due to lack of workers or lack of incentives.

Questions on Sustainability

16. Since the end of JICA's cooperation program in 2004, has MARDI continues with the experimental study on the feed management project?

Since the end of JICA's cooperation program, MARDI's activities on this project has in fact increased drastically, owing to the fact that there is an increased in interests on the OPF feeds from various organizations and the private sector.

17. What other improvements if any, has MARDI achieved in terms of upgrading the quality while reducing production cost of the OPF Feed since 2004?

MARDI has continuously trying to improve the manufacturing process to reduce cost. The old method of harvesting has give way to new systematic and on site shredding method of harvesting the fronds using automatic harvester. For instance, the OKADA system introduced by the Japanese for drying the raw materials using solar energy employed three units of automatic bridge with stirring arms. Our engineers have improved this system by incorporating new features that can also blow up the shredded materials to speed up the drying process. We found that with this new feature, we are able to speed up the drying process from 5 days to 2-2.5 days. This is significant. We also install standby industrial fans to help circulate the air during days when the air is too still.

We have also tested the quality of the beef produced from cattle fed with our OPF complete feed. The beef quality if in fact superior than those fed with conventional feed. The beef is found to have less fat, more protein and tasted good.

18. Are all the counterparts involved in the JICA OPF project still with MARDI? And are they still continuing on the works related to the OPF project in MARDI?

Except for those who have retired, most of the counterparts are still working in MARDI and in the OPF Project.

19. Has MARDI identified ways to overcome the problems of shortage and transport of raw materials to the pilot plant?

The harvesting and transport of raw materials to the factory constituted about 30% of the cost of production. Therefore, this was the first area MARDI tackled to reduce the cost. Instead of manual harvesting and transport the fronds to the factory for shredding, now we use automatic shredding machine on site, after trying out many shredding machines with different cutting sizes and speed. Now the harvesting and shredding are done on site and this make it very cost efficient. They can also be stored with minimum exposure to oxygen to prevent oxidation in Silager form.

We only harvest and use fronds from palm trees that are at least 5-10 years old. As trees age, they lose their protein contents, while too young, the leaves lack fibers.

20. During the F/U period, the production capacity of OPF Feed by the pilot plant was estimated to be 2000 ton a year. What is the current situation? Is this production sufficient for MARDI to carry out more experimental tests of the feed for farmed animals?

The current situation is we are still using the same capacity, producing about 2.5/hr or 10-12 tons per 8 hrs shift using 4 persons. If we run more shifts, we are able to produce 300-500 tons a month. We are able to maintain this pilot plant using the budget allocated by the Ministry. To renew this plant or expand its capacity, we would require further injection of investment fund. Our current production is still not enough to meet requests from interested parties.

21. Has MARDI continued to receive sufficient financial / budgetary allocation it needs from the Ministry or from the Treasury to continue with the R/D on OPF feed, maintenance and operation of the pilot plant and implementing the incubation program?

MARDI has continued to receive the necessary funding from the Government to continue its R/D program, its incubation program and to maintain and operate the pilot plant at MARDI.

22. What is the status on the patent applications to SIRIM?

The application to SIRIM on the patent for the MARDI-JICA manufacturing process of OPF Feeds are still pending.

23. Has the recent increases in palm oil prices affected the OPF project in any way?

No. Considering we have 4.4 million hectares of oil palm plantations, there is enough for all, including bio-fuel.

Date: 16th April, 2007

JICA-MARDI OPF Plant,
MARDI, Serdang, Selangor
Mr. Yunus Hussain (MARDI), Mr. Jamil Md Yasin (FELDA),
By: Mr. Chua and Aishah (IC. Network Sdn Bhd)

On Incubation Program

1. FELDA has two special projects with special funding that focus on the breeding of beef cattle in Chuping, Perlis and the OPF feed factory in Bkt. Sagu in Pahang. I am originally a plantation manager and sent to MARDI for training on the OPF project for the last 1 and half year. The two special projects are actually inter-related.
2. The OPF factory in BKT SAGU is nearly completion. The target production volume of this plant is 1000 ton/mth with 1 shift of workers for the 1st year. For the 2nd year onwards, we plan to produce 3,000 tons of OPF/month with 3 shifts of workers.
3. We shall be producing three types of products, namely 100% OPF cubes (20% share), OPF Complete feed pellets for beef cattle (30%) and the rest OPF complete feed for Boer Sheep. The beef cattles are the Brahmas-KK breed, which is the Indian Brahma stock crossed with our local Kedah-Kelantan Breed. MARDI has found that this cross-breed perform best with the OPF complete feed. We also found that the South African Boer sheep perform very well with the OPF Feed. We found that these sheep reaches its optimal size for meat at 40kg per head.
4. One cattle requires 6kg of feed a day. The 1000 ton production a month would be able to feed at least 5,500 head of cattle. Currently FELDA has about 6000 head of cattle being farmed.
5. The MARDI Pilot Project Plant can produce 2 ton/hour or about 10-12 ton/day or 250-300 tons/mth. The feed produced here are used for MARDI's experimental feeding schedule for two beef cattle stations in Johor (in Keluang and Pagoh), some for ISO breeding project and the remainder to 3 local farmers. This volume of local farmers is small, about 3 ton/month at RM650 / ton.
6. FELDA sent two persons to be trained by MARDI. We pay about RM2000/mth for rental of the premise and RM500,000 for the whole program to MARDI for the training, permits and others. FELDA shall also contribute 5% of its production to MARDI after its plant begin its operation. MARDI shall continue to provide supports and advice to FELDA.

7. Out of the 4.4 million ha of oil palm plantation in Malaysia, 60% is owned by FELDA. Currently, FELDA is producing other forms of feed using PKC. The OPF is a new form of feed. Compare to PKC feed which also contains added nutrients, the OPF feed is more suitable for beef cattle and sheep as it contains higher fiber contents, thus prolonging its digestion period in the animals, which enable the animals to derive more nutrients from the feeds.

Impact on the Oil Palm industry and others

1. Previously, palm fronds are cut down when they harvest the fruits and left to rot on the plantation. The fronds return some of the nutrients to the soil. By harvesting the fronds for the OPF feed, we are actually cutting off this natural replenishment of nutrients to the soil. We might have to spend money fertilizing the soil.
2. On the other hand, we used to obtain the fronds free, and the cost is just cost of transport which was about RM25/ton. But now we have to pay about RM60/ton to private plantation owner for the fronds. We have to reduce the cost of transport to about RM14-16 per ton..
3. On the impact of other new industry such as bio fuel project, the bio fuel uses more of the by products of fruits, rather than fronds. Fruit production per ha of oil palm estate is actually higher, at 35-40 tons of wet weight per ha per year, compared to fronds, which is only 24 ton/ha/year.

On external factors that may hinder the OPF project

1. One of the problem I faced is the supply of raw materials. Although FELDA has huge plantation to supply the fronds I need, which I estimated to be about 15ton/month once I start operating the Bkt Sagu plant, those who wish to commercialize the OPF feed industry will face problem from this major external factor. This is because, the harvesting of frond is not as easy as one thinks. First of all, it requires labor specifically assigned to cut down the fronds. Plantation workers normally will only cut the fronds if they obstruct the harvesting of the fruits. Therefore, even for FELDA settlers, if there is no incentives for them to cut the fronds, they would not do it. Fruits need to be harvested and transported quickly to the factory before they lose their oil contents. Hence, workers need a whole new set of schedule if they want to cut down the fronds.
2. The cost of machinery needed to process the fronds into feeds is very high. This initial investment is what frightens off many private potential entrepreneurs. The automatic harvester for example cost as much as RM500,000. The manual one cost about RM100,000 but requires more labor input. But even the automatic harvester, requires the fronds to be brought out from the base of the palm tree to say, the roadside and placed in a straight line for the harvester to grip the fronds and feed into the shredder truck.

3. The other problem is bureaucratic red tapes. As FELDA is a quasi government agency, there are many procedures and rules to follow, especially when it comes to apply for budget to operate and maintain the machinery, to buy raw materials, etc. For example, when I apply for a budget to buy the added nutrients to the feed, the price may be at RM10 a ton, but by the time I get approval several months later, the price of this materials might have gone up. Vendors supplying materials to FELDA and other government agency often have to mark up their prices, as contracts are often one year, and to counter such risk and also payment delay, these vendor may quote a price that is much higher than the open market price. Commercializing OPF feed in FELDA faces such problem.
4. To reduce cost of OPF, the 100% OPF feed without any added ingredients which is also highly demanded by China, Korea, Japan are more competitive and potential to yield higher returns. OPF complete feed is more difficult to reduce its cost of production. Therefore, FELDA has to make a high level decision, whether to produce the 100% OPF cubes for export or to produce complete feed for domestic market and some other markets like Middle East and Africa. A balance might be more realistic.
5. Once FELDA is able to produce the feed, marketing to these foreign countries poses a challenge. To export to Japan, maybe the Association of Animal Feeds in Japan through JICA can assist us to market the product to Japanese farmers.

On sustainability

1. To achieve sustainability of the OPF project, settlers in FELDA must be given some form of incentives or participation to encourage them to supply the fronds to the OPF Factory. Without which, the plant may face higher costs in purchasing and transporting fronds to the factory.
2. Realizing the high cost factor in transportation of either the raw materials and finished products, it is best that many small factories be set up and widely distributed among the FELDA schemes. Then these products are collected into a major collecting centre, may be close to a port for easy access to foreign markets.
3. The Japanese 5S system is good to instill discipline to the Malaysian workers. But for such system to work, we requires also rewards system. To workers who have initiatives to carryout 5S, we needed to reward them and give incentives. In government agency like MARDI or quasi government agency like FELDA, we find it hard to implement and sustain such 5S system. Workers easily lose interests and incentives to continue. In the private sector it is different. The Manager can easily build in an incentive system to encourage the workers.

On Production Process

1. The harvester is still a problem. The auto harvester has only a small capacity and it works best on flat terrain. On hilly terrain, it still requires more labor inputs. Cost is a factor.
2. The agitator (Okada System) from Japan was substantially improved at MARDI. The moisture contents of the shredded material is about 65% and it gets to reduce to about 20% after 1.5 days at this improved system. The improved system uses solar heat as well as industrial fans to dry the materials.
3. Once it is dried, it feeds into a conveyor belt and get transported into a temporary storage silos. From here, it is convey up to a secondary drying facility using diesel powered hot air blower to reduce the moisture content to about 15%. This is then milled into fine particles. The milled materials is then either fed into the machine that process it into 100% OPF Cubes, or into a mixer cylinder, where other nutrients (such as bran, corn, tapioca, etc) are added using automatic programming controls. After they are thoroughly mixed, they are convey to a pelletization machine (German Kahl machine). Here, a controlled moisture using steam is added to congeal the materials into pellet form. The final product is then stored in silos and ready for bagging. Each bag is 40kg, and 25 bags make 1 ton of feed.
4. Since all materials used are dried natural ingredients, there is very little pollutants or hazardous dust in the air. Although it is dusty, there is no danger to inhale the dust. Masks are provided to all workers, but they hardly use them.
5. The present MARDI plant is a R/D facility. Therefore it is also used to test out other kinds of feeds, such as those using straw (padi stalks), etc. to provide inputs to other projects such as those involving poultry farming.
6. On the whole, the pilot plant is working fairly well, except for some minor repairs and maintenance problems, it is operating satisfactory to produce about 2 ton/hour of OPF feed to supply and support MARDI's experiments with some leftovers for local farmers. Overall, MARDI has managed to improved the process and reduce the number of workers needed for operating the factory from about 15 to 5 persons per shift.
7. This is quite impressive and the plant receives many overseas and domestic visitors every year, including those from Japan and ODA monitoring teams.