

<b>Project Title</b>	<b>Building Aquafeeds R&amp;D Capacity for Intensive Aquaculture in Vietnam</b>
<b>Code: 1.14</b>	
<b>Australian Personnel</b>	Dr Kevin C Williams
<b>Australian Institution</b>	CSIRO Division of Marine Research
<b>Vietnam Institution</b>	University of Fishery
<b>Project Duration</b>	July 2000 to June 2002

## **Project Description**

The overall objective of the project is to increase food security and income of rural Vietnamese in coastal communities by improving the profitability, and environmental sustainability, of intensive aquaculture in Vietnam. This addresses identified priorities of the CARD Program to build capacity in areas of fisheries and aquaculture and livestock feed improvement. This will be delivered by building the teaching and research base for aquaculture nutrition at the University of Fisheries (UoF) at Nha Trang.

By developing this capability, aquaculture nutritional research carried out in Vietnam will develop cheaper, better and more environmentally responsible aquafeeds.

Additionally, aquaculture graduates and postgraduates in Vietnam will become more proficient in aquaculture.

## **Objectives**

Aquaculture graduates and postgraduates in Vietnam will become more proficient in aquaculture feed technology with this knowledge being applied for long term benefits to Vietnamese culture. Through these mechanisms, intensive aquaculture in Vietnam will become more ecologically sustainable and profitable.

Australia will derive benefit through complementary research being carried out to develop formulated pelleted diets for the on-growing of tropical rock lobsters - an emerging aquaculture industry in Australia. These outcomes will be achieved by:

- a) Developing a collaborative aquafeed research project between CMR and UoF to facilitate technology transfer between Australia and Vietnam for the mutual benefit of aquaculture sectors of both countries
- b) Providing training to increase the aquaculture nutrition skill base at UoF and to provide Vietnamese post-graduates with opportunities to study aquaculture nutrition.
- c) Disseminating and show-casing project achievements at scientific forums, by the holding of a technical workshop in Vietnam and extension of research findings to the aquaculture industry.

## Outputs and Performance indicators

Outputs	Performance Indicators
<p><i>UoF Outputs</i></p> <ul style="list-style-type: none"> <li>◆ Audit of feeding practises used in the intensive culture of tiger shrimp, grouper and lobster in central/southern coastal Vietnam</li> <li>◆ Inventory of manufactured aquafeed and feedstock supplies available in central/southern coastal Vietnam</li> <li>◆ Database on the biochemical composition of aquafeeds and agricultural/fishery commodities identified as having significant potential for use in pelleted aquafeeds.</li> <li>◆ Guidelines for the improved use of trash fish for intensive culture of grouper and rock lobster</li> <li>◆ Capability at UoF to undertake aquafeeds R&amp;D</li> </ul>	<ul style="list-style-type: none"> <li>i) Scheduled project activities are completed on time (staff employed, facilities established and experiments completed)</li> <li>ii) AusAID is provided with reports of project activities at six-monthly intervals and the final report by 31 August 2002</li> <li>iii) Improved trash fish feeding practises for intensive grouper and lobster culture are being adopted in Vietnam</li> </ul>
<p><i>CMR Outputs</i></p> <ul style="list-style-type: none"> <li>◆ Highly attractive/palatable pelleted diets developed that stimulate food consumption and promote growth and development of juvenile tropical rock lobsters</li> <li>◆ Nutritionally-balanced pelleted diets for growth and development for juvenile rock lobsters developed</li> <li>◆ Pelleted diets for tropical rock lobster that have a low resilience on fishery product</li> </ul>	<ul style="list-style-type: none"> <li>iv) Pelleted diet are developed that enable juvenile tropical rock lobsters to grow at rates equal to or better than that achieved with natural foods</li> <li>v) The requirements of rock lobsters for high-cost nutrients are determined</li> <li>vi) Training UoF personnel in aquaculture nutrition research methodology and nutritional chemistry analysis is provided by CMR through staff exchange visits and supervision of postgraduate students</li> </ul>
<p><i>Increasing the aquaculture nutrition skill base at UoF</i></p> <ul style="list-style-type: none"> <li>◆ Research facilities developed at UoF for aquaculture nutrition research</li> <li>◆ UoF staff trained in aquaculture nutrition research methodology</li> <li>◆ Curriculum developed for undergraduate teaching of aquaculture nutrition at UoF</li> <li>◆ Postgraduate studies in aquaculture nutrition at UoF</li> </ul>	<ul style="list-style-type: none"> <li>vii) Research findings are widely and speedily communicated to industry and the scientific forums and the holding of a workshop in Vietnam to report project activities</li> </ul>

<p><i>Disseminate project findings</i></p> <ul style="list-style-type: none"> <li>◆ Papers and extension aids reporting project findings to the scientific community and to industry</li> <li>◆ Workshop in Vietnam to show-case and publicise project findings</li> </ul>	<p>viii) Aquafeed manufacturers in Vietnam use project findings to develop improved pelleted feeds, especially for shrimp and grouper culture.</p>
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## PROJECT COMPLETION REPORT

### Executive Summary

The aim of the CARD Project was to build increased capacity for aquafeed development in Viet Nam. This was achieved through the training of University of Fisheries (UoF) staff and post-graduates in aquaculture nutrition and the initiation of collaborative research with CMR on feed development for grouper fish. In Viet Nam, the research work forms part of a PhD study being undertaken by Le Anh Tuan at UoF; Ms Mai Nhu Thuy is enrolled for a Master of Aquaculture with aquaculture nutrition her nominated specialty study.

All milestones for the Project, which officially ends 30 June 2002, have been met. However, ongoing research work by Le Anh Tuan to fulfill requirements for his PhD, including a further 3-month placement at CMR from July to September 2002 and in-Australia training of Master's postgraduate Ms Mai Nhu Thuy at Cleveland during August 2002, will provide ongoing communication and collaboration between CARD staff at both Centres. The CARD project has enabled a fully equipped feeds processing and seawater nutritional research laboratory to be constructed at UoF at a materials and equipment cost of about AUD\$55,000. This facility will remain to support ongoing aquaculture nutrition research at UoF.

Training of UoF staff in aquaculture nutrition has been an essential part of the CARD Project. In addition to the on-going supervision of postgraduate studies being undertaken by Mr Tuan and Ms Thuy, dedicated in-country and in-Australia training has been provided by CMR staff: in-country training in feeds processing and fish nutritional experimentation was provided by Mr Simon Tabrett in March 2001; Mr Tuan received training in all facets of aquaculture nutrition during 3 to 4 month placements at CMR in 2001 and 2002; Ms Binh spent 3 weeks at CMR in August 2001 for training in nutritional analytical chemistry and this was consolidated with in-country training in gas chromatographic procedures for analyzing fatty acids provided by Ms Margaret Barclay in April 2002. Ms Thuy will visit CMR in August 2002 for training in seawater laboratory procedures.

The key nutritional requirements of grouper have been determined and pelleted feeds based on the use of dried marine and terrestrial feed ingredients have been developed and shown to be equally as good for feeding grouper as traditional feeds of 'wet' trash fish. Dr Mao (UoF Project leader) and Mr Tuan, together with CMR staff, Dr Kevin Williams, David Smith and Simon Irvin, will attend and contribute papers at a marine finfish workshop being held 30 September to 04 October 2002 at Halong City, Viet Nam. This meeting will provide an ideal forum to showcase the research carried out in the CARD project and to extend these findings to the Vietnamese aquaculture feeds industry. Additionally, research carried out jointly in the CARD and an ACIAR grouper aquaculture project, is to be showcased at a large ACIAR Fisheries Expo being staged in Jakarta, Indonesia, from 28 to 30 July 2002.

The CARD Project has successfully equipped UoF with excellent aquaculture nutrition research facilities and increased the skill base of its staff in this discipline. It is expected that aquaculture nutrition will now become a more important undergraduate course at the university and that the university will offer postgraduate studies in this area. This outcome was possible only through the strong support for the CARD Project by the University's Rector, Professor Dr Quach Dinh Lien and the willing participation of all Project staff. However, for there to be a long-lasting outcome and real progress in self-determined aquafeed development in Viet Nam, the present achievements of the CARD project need to be consolidated through carriage by the University of continued teaching of aquaculture nutrition to undergraduates and postgraduates and for proactive research in aquaculture nutrition. It is recognized that a sustained effort in aquaculture nutrition at UoF may not be possible without additional external funds.

## **1. Project Description**

### **1.1 Background and preparation**

The project arose directly as a result of an *Aquaculture Feeds Consultancy for Cage Mariculture in Khanh Hoa Province, Viet Nam* that Dr Williams, CSIRO Marine Research (CMR), carried out in January 2000. The consultancy was commissioned by the Asian Institute of Technology, Bangkok (AIT) and supported financially by the Department for International Development, UK (DFID) and the Australian Centre for International Agricultural Research (ACIAR). The Consultancy complemented a DFID project on *Improved Management of Small-scale Tropical Cage Culture Systems in Asia*, which in Viet Nam involved the University of Fisheries (UoF). The objectives of the aquaculture feeds consultancy were to appraise the efficiency and effectiveness of feeding practices currently employed in the cage culture of rock lobsters and groupers in Viet Nam's Khanh Hoa province, and to make recommendations as to how better feeds and feeding practices could be instituted for the long-term sustainability of these industries.

Cage mariculture in Viet Nam depended entirely on the feeding of fresh fish and shellfish (trash fish). The employed feeding practices were highly inefficient with up to 30 kg of trash fish being used to produce 1 kg of cultured grouper or rock lobster. Since only 4 to 5 kg of trash fish should be needed biologically to produce 1 kg of cultured 'fish', a 4 to 6 fold wastage of the food was occurring which not only affected profitability but was having severe environmental impacts on the adjacent waterways. Moreover, decreasing fishery production due to heavy exploitation of inshore fisheries and aquaculture's increasing demand for trash fish were causing fish prices to escalate and greater competition between 'man' and aquaculture for the decreasing supply. One of the recommendations arising from the aquafeeds consultancy was for UoF to develop an aquaculture nutrition capability in order to provide the teaching and research base in aquafeeds technology needed for ecologically sustainable expansion of intensive mariculture in Viet Nam. The CARD project was developed to address this need.

### **1.2 Context and rationale**

UoF is the only university in Viet Nam solely dedicated to the tertiary teaching of fisheries science. Although having a strong School of Aquaculture, teaching staff at UoF had very little expertise in aquaculture nutrition and undergraduates were given only a rudimentary course in nutrition. The CARD Project provided an opportunity to address this inadequacy. The greatest priority was to train staff in aquaculture nutrition and the best way of achieving this goal in the limited time available in the CARD Project was to initiate a program of

aquafeeds research at UoF that could be integrated with on-going research at CMR. This approach would enable training needs of staff to be identified and targeted training provided to address this need while ensuring that additional infrastructure was provided for long-term capacity building in aquaculture nutrition. If successful, the CARD Project would increase the aquaculture nutrition skill base of staff at UoF and provide the university with long term benefits well after the CARD Project was completed.

### 1.3 Project objectives and scope at design

The key activity of the CARD project was to establish a collaborative aquaculture research project between CMR and UoF. This collaboration would afford opportunities for UoF staff and post-graduate students to increase their competency for carrying out scientifically rigorous and meaningful aquaculture nutrition research. The collaboration would provide Viet Nam with an increased capacity in aquaculture nutrition to enable continued and ecologically sustainable development of intensive aquaculture in the country. At UoF, the research sought to develop best feeding practices for using bait/trash fish as a food source for intensive marine cage aquaculture and subsequently, to initiate research to reduce the reliance of these intensive aquaculture industries on feeding trash fish. The research at UoF was seen to complement grow-out feeds development work being done in an ACIAR grouper project (FIS/97/73: *Improved hatchery and grow-out technology for grouper aquaculture in the Asia-Pacific region*) at CMR and in participating laboratories in Indonesia and the Philippines. Findings from the ACIAR research would have immediate relevance and transferability to Viet Nam. It was intended that the Australian research element would focus on pelleted feeds development for tropical rock lobster as a complement to an Australian Fisheries Research and Development Corporation (FRDC) project that is investigating the nutritional requirements of the tropical spiny lobster, *Panulirus ornatus*. The same species is being intensively cultured in Viet Nam but with a total reliance on the feeding of fresh (natural) foods.

### 1.4 Implementation arrangements

Overall project management was the responsibility of CMR’s Dr Williams with in-country work the responsibility of UoF’s Aquaculture Faculty Head, Dr Nguyen Dinh Mao. Progress of the Project was tracked by frequent visits by Dr Williams to UoF and regular staff exchanges between the two Agencies. Key staff of the Project attended the annual project meeting of the ACIAR Grouper Aquaculture Project which provided a further learning experience in the way aquaculture research is conducted and reported. Reporting of CARD progress was organized by requiring UoF to provide CMR with a written report of project activities and financial acquittal every 6 months. CMR provided AusAID (through Illawarra Technology Centre) with 6-monthly reports of the Project’s Progress and annual financial acquittals.

## 2. Appropriateness of Project Design and Objectives

### 2.1 Appropriateness of Objectives

Obj No.	Objective Description	Rating
1	Develop a collaborative aquafeed research project between CMR and UoF to facilitate technology transfer between Australia and Viet Nam	5
2	Provide training to increase the aquaculture nutrition skill base at UoF	5
3	Disseminate and show-case project achievements	5

Appropriateness rating:- 5; Best Practice; 4: Fully Satisfactory; 3: Satisfactory Overall; 2: Marginally Satisfactory; 1: Weak.

## 2.2 Appropriateness of Design

Description of design feature	Rating
The Project comprised three design elements, which aligned with the three objectives as stated above. Brief comments about each and an appropriateness rating are detailed below.	5
1. <i>Develop a collaborative aquafeed research project.</i> This provided the best teaching method for raising the aquaculture nutrition skill base of UoF staff. It ensured that UoF staff gained hands-on experience in carrying out aquaculture nutrition research including problem identification, planning appropriate research procedures to address the problem (thus requiring the acquisition of aquaculture nutrition knowledge about the particular subject area), developing the necessary infrastructure and technical know-how to engage in the research and sensibly interpreting the results emanating from the research.	5
2. <i>Provide training in aquaculture nutrition.</i> The provision of targeted training, both in Viet Nam and in Australia was seen as a critical element if any sustained benefit of the CARD Project was to be achieved. It was recognized that training would have to be provided at two levels: very targeted training to address specific skill areas that would be required by UoF staff to engage in the planned research program; and sustained training of a limited number of UoF staff across a broad skill base as could be instituted as part of a dedicated post-graduate course in aquaculture nutrition. For the former training, short course activities of 2 to 3 weeks duration to teach specific skills were envisaged to be provided by CMR staff. For the latter training, it was hoped that at least one person attached to UoF would enroll for either a Masters or PhD in aquaculture nutrition under the co-supervision of appropriate staff at CMR.	5
3. <i>Disseminate and showcase Project achievements.</i> Not only important in demonstrating the value of the CARD Program, this element was important for UoF staff to gain experience in presenting research findings and reporting the progress of Project activities at national and international forums.	5

Appropriateness rating:- 5; Best Practice; 4: Fully Satisfactory; 3: Satisfactory Overall; 2: Marginally Satisfactory; 1: Weak.

## 3. Implementation Performance

### 3.1 Project Components and Outputs

Component	Outputs	Performance Indicators	Rating
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1	Develop a collaborative aquafeed research project	Collaborative aquafeeds research between CMR and UoF is developed	1.1 Seawater research facilities and feeds processing equipment established at UoF 1.2 Audit made of feeding practices and feedstock supplies for intensive aquaculture in central-southern Viet Nam 1.3 Database developed on the biochemical composition of feedstock supplies in Viet Nam 1.4 Guidelines developed for the improved use of trash fish for intensive culture of grouper 1.5 Cost-effective and highly productive pelleted feeds developed for grouper 1.6 Enhanced capacity at UoF to initiate aquafeeds R&D	5 5 5 5 5 5
2	Provide training in aquaculture nutrition	Aquaculture skill base of UoF staff is significantly increased	2.1 Postgraduates enrolled in Masters and PhD studies in aquaculture nutrition 2.2 UoF staff trained in lipid chemistry analysis 2.3 UoF staff trained in experimental procedures for aquaculture nutrition research	5 5 5
3	Disseminate and show-case project	Card Project results are disseminated at national and international meetings	3.1 Papers and extension aids reporting project findings at scientific and industry meetings 3.2 Workshop in Viet Nam to showcase project findings	4 5

Rating:- 5: Exceeding time and quality targets; 4: Achieving time and quality targets and on budget; 3: Moderate progress towards targets, some issues about quality, budgets or costs but these are being adequately addressed; 2: Some progress towards targets, but slippage in schedule and cost over-runs; 1: Significant problems in achieving targets, quality outputs unlikely to be achieved and substantial cost increases affecting overall budget

Changes to the implementation of the project were minor and essentially inconsequential. Commencement of the project was delayed by about five months owing to issues relating to the Terms of Contract between CSIRO and AusAID. This delay was overcome by an increased effort by both CMR and UoF so that all of the planned work was completed as scheduled on 30 June 2002. The work program at CMR was changed by using grouper fish instead of lobsters as the research model for aquafeed development. This change was necessary because of the poor recruitment of juvenile lobsters in Queensland waters during the 2000/01 season and consequently the lack of suitable lobsters to initiate this research. This actually was a positive for the project as it enabled complementary feed development research to be carried out on grouper fish at both UoF and CMR. This had the effect of providing a more direct and better teaching model for aquafeed capacity building at UoF while speeding up the overall progress in grouper diet development, and thus increasing the benefit of the Project to both Viet Nam and Australia.

### 3.2 Project Outcomes

The CARD Project has successfully put in place at UoF the infrastructure and technical know-how necessary for staff to engage in aquaculture nutrition research. Through the implementation of collaborative research on feeds development for grouper fish and targeted training activities, UoF has now a far greater capacity to teach aquaculture nutrition to undergraduates and is gaining some expertise to supervise postgraduate studies in this

discipline. However, it must be recognized that unless there is external funding support for continued research effort in aquaculture nutrition at UoF, the capacity built-up in the CARD Project could quickly be dissipated and lost.

### **3.3 Sectoral Impact**

The CARD Project has been gender and community neutral, affording an equal opportunity to UoF staff to participate in the project. Two females (Ms Binh and Thuy) have participated in training activities carried out in Australia and postgraduate studies in aquaculture nutrition have been initiated by one male (Mr Tuan) and one female (Ms Thuy) student. If there was any bias in the selection of staff engaged on the CARD Project, it was towards those having some competency in English language.

### **3.4 Costs and Financing**

Project expenditure was closely aligned with the budget. There was a small under-expenditure in travel (\$7,760 or 7.5% of travel budget), which was offset by a similar over-expenditure on non-personal input costs (\$11,311 or 5.7% of non-personal input budget). Overall, total expenditure was just \$135 over the total budgeted amount. The Financial Acquittal for Year 2 (01 July 2001 to 30 June 2002) is detailed in Appendix A1.0 while that for the whole project (01 July 2000 to 30 June 2002) is in Appendix A1.1.

### **3.5 Monitoring of Project**

The regular visits and exchange of staff between CMR and UoF as was necessary for scheduled training activities were important for monitoring the Project's progress. Additionally, the formal requirement of CMR for UoF to provide 6-monthly written reports of project activities and financial acquittals was an important instrument for monitoring the Project. However, above all else, the willing cooperation of UoF staff at all organizational levels in all facets of the CARD Project ensured that the project ran smoothly and successfully achieved the intended outcome.

### **3.6 Technical Assistance, Training and Capacity Building**

The focus of the project was to build teaching and research capacity in aquaculture nutrition at UoF. This would enable this discipline to be more effectively taught at undergraduate and postgraduate level and provide a foundation for the university to embark on aquafeeds research. Through these measures, it was expected that Vietnamese graduates of the university would become better versed in aquaculture nutrition and through either direct employment by the feeds industry or through Government advisory services assist Vietnamese aquaculture industry (feeds processors and farmers) to become more proficient in all facets of aquafeeds production and use in intensive aquaculture. There was strong recognition by UoF of the need for staff to acquire greater proficiency in aquaculture nutrition. Thus the project team assembled from Aquaculture faculty members had strong motivation to gain expertise in this discipline and were willing and attentive participants in all elements of the CARD Project. Without this high level of personal and university commitment, the CARD Project would not have been able to successfully deliver all planned outcomes. Similarly, the equally strong commitment of CMR staff to service the Project's needs and especially the delivery of training courses, was another feature that greatly assisted in the success of the project. The training courses organized and run at UoF and in Australia were a vital process in raising the aquaculture nutrition skill level of the Project participants. Moreover, it is expected that the benefit of this training will remain long after completion of the CARD Project.

### **3.7 Management of Constraints, Issues, Risks and Change**

The difficulty in Year 1 of procuring lobster seed in Australia necessitated the Australian research component of the CARD Project being redirected to examine feeds development for grouper fish. This value-added and complemented the feeds development research being carried out on grouper at UoF and that being done at CMR as part of the ACIAR Grouper Aquaculture Project. This has enabled greater progress to be made in understanding the protein to energy and lipid requirements of grouper fish (Annex III).

### **3.8 Project Management**

Apart from administrative matters between CSIRO and AusAID that delayed the start-up of the project by about 5 months, there have been no management problems affecting the CARD Project. All Progress Reports were submitted on time. All in-country visits by CMR staff for training activities and project monitoring proceeded as planned.

The UoF has been a very willing and enthusiastic collaborator in the CARD Project. Written 6-monthly reports of CARD activities in Viet Nam and acquittal of monies spent on the CARD Project have been provided punctually to CMR. The CARD Project, and all project activities, has the strongest support of UoF administration.

Performance of UoF is rated: 5

Performance rating:- 5; Best Practice; 4: Fully Satisfactory; 3: Satisfactory Overall; 2: Marginally Satisfactory; 1: Weak.

## **4. Performance and Outcomes**

### **4.1 Assessment of Performance Against Objectives and Design**

All three key objectives of the CARD Project – to develop collaborative aquafeed research, to train UoF staff in aquaculture nutrition and to disseminate and showcase the project findings – have been successfully achieved. Noteworthy has been the genuine willingness of UoF staff to participate and collaborate fully with CMR in the development and subsequent implementation and management of the CARD Project. Major outputs of the CARD Project include:

- Establishment at UoF of an aquafeeds processing and seawater laboratory that is dedicated to aquaculture nutrition research and teaching (Appendix A2.0).
- Establishment of a collaborative research project on grouper fish nutrition between CMR and UoF. This has advanced our knowledge of the protein to energy requirements of grouper fingerlings and identified marked differences between groupers and temperate species such as salmonids in the way lipid is assimilated and metabolized (Appendices A3.0 and A4.0).
- UoF staff has gained expertise in aquaculture nutrition experimental methodology and nutritional analysis through targeted in-country and in-Australia training provided by CMR.
- Four final year Aquaculture Science students have chosen to do a nutrition project in fulfillment of the University's course requirement for project work. Two postgraduate students, Miss Thuy and Mr Tuan, have enrolled for Master and PhD studies, respectively, in aquaculture nutrition at UoF.
- The research findings of the CARD project were showcased at an ACIAR Fisheries Expo held in Jakarta, Indonesia on 30 July and at a Marine Finfish Workshop being staged

jointly by NACA and ACIAR at Ha Long City, Viet Nam from 30 September to 05 October 2002.

As a result of the CARD Project, the capacity of UoF to provide effective tertiary teaching of aquaculture nutrition and to engage in aquafeeds research has been greatly strengthened. This is a significant outcome for the project. A second major outcome is the collaborative links that have been forged between CMR and the UoF, in particular, and more broadly with other aquaculture feeds research agencies in Viet Nam. It is hoped that these links will be further strengthened through future collaborative projects.

## **4.2 Sustainability**

The CARD Project has installed at UoF the necessary infrastructure (feeds processing and seawater experimental facilities) and provided key staff at UoF with basic training in experimental methodology and analytical chemistry that is necessary for carrying out aquaculture nutrition research. Importantly, the awareness of aquaculture nutrition has been significantly raised, specifically within UoF but more widely amongst the Vietnamese aquafeeds industry and the scientific and commercial aquaculture community in Viet Nam. The further development of the aquaculture nutrition curriculum at UoF will have long reaching benefits in stimulating the interest of undergraduates and postgraduates in this aspect of aquaculture. Although there can be no question that the CARD Project has considerably built increased capacity at UoF for the tertiary teaching of aquaculture nutrition and the undertaking of research in this discipline, the extent to which this capacity will be maintained is problematical. With such a short CARD Project, it has been possible to put in place only the basic structure and training needed to establish some capacity at UoF in aquaculture nutrition. An ongoing expansion of this effort is critical if this capacity is to be maintained and grown. This will be possible only if external funds can be procured to support and build on the foundation provided by the present CARD Project.

There is a scarcity of internal funds at UoF to support the continued maintenance of laboratory facilities and consumables (especially for the analytical chemistry laboratory but also in respect of the seawater and feeds processing equipment which have high maintenance cost) as would be necessary for an ongoing research (and effective teaching) effort in aquaculture nutrition. Moreover, the aquaculture nutrition skills base at UoF is still very low and in spite of the emphasis in the present CARD Project to address this issue by targeted in-Australia and in-country training. Much of the skills development has, by necessity, been directed at building nutritional expertise of Mr Le Anh Tuan in order to facilitate his PhD studies. Should Mr Le Anh Tuan decide to leave UoF upon gaining his PhD, it must be accepted that much of the CARD Project's capacity building at UoF – at least in human resource development – would also be lost. While other CARD Project staff at UoF is now much better versed in aquaculture nutrition, it is likely that this knowledge would rapidly be lost without the presence of an ongoing program in aquafeeds research. Continued external fund support is critical to ensure that aquafeed teaching and research capacity built at UoF in the present CARD Project is not lost.

Sustainability rating: 4.

5: Best Practice; 4: Fully Satisfactory; 3: Satisfactory Overall; 2: Marginally Satisfactory; 1: Weak.

### **4.3 Development Impact**

The CARD Project has provided UoF with a dedicated seawater laboratory and ancillary feeds processing equipment that can be used for teaching and research of aquaculture nutrition. The expertise of UoF staff in aquaculture nutrition has been greatly enhanced through the CARD Project. It is anticipated that there will be a greater emphasis at UoF to teach a more advanced course on aquaculture nutrition to undergraduates and to provide postgraduate studies in this discipline at both Master's and PhD levels. The long term benefit of the CARD Project will reside in UoF graduates who will be far more proficient in the science of aquaculture nutrition which can be applied to increase the efficiency, profitability and sustainability of Vietnamese blossoming aquaculture industry.

## **5. Conclusions**

### **5.1 Project Achievements and continuation of the CARD Program**

The CARD Project has successfully put in place a strong infrastructure and human resource foundation at UoF for tertiary teaching and research in aquaculture nutrition. This outcome was possible only through the strong support for the CARD Project by the University's Rector, Professor Dr Quach Dinh Lien, and the willingness of all UoF staff and particularly that of Dr Nguyen Dinh Mao, Head of Aquaculture Faculty and Vietnamese CARD Project Leader, to engage fully in all project activities. This outcome is also an acknowledgement of the commitment of CMR staff to make the Project a success and to contribute their knowledge and expertise to ensure that all training elements of the Project were met.

However, for there to be a long-lasting outcome and real progress in self-determined aquafeed development in Viet Nam, the present achievements of the CARD project need to be consolidated through carriage by the University of continued teaching of aquaculture nutrition to undergraduates and postgraduates and for proactive research in aquaculture nutrition. If these activities can be sustained, UoF will play a crucial role in providing Vietnamese graduates with a good knowledge of aquaculture nutrition, which, in turn, will advance aquafeeds development in Viet Nam. It is recognized that a sustained effort in aquaculture nutrition at UoF will be possible only with additional external funds. An extension of the existing project for a minimum period of 12 months to consolidate the aquafeed capacity building so far achieved in the Project is recommended. Such an extension would not need funds to support research at CMR other than that which might be done as a training aid, eg in support of continued research by PhD student, Le Anh Tuan. Alternatively, continuation of the CARD Program and the awarding of a project to continue aquafeed capacity building at Uof and also involving the Regional Institute of Aquaculture No. 3 (also based at Nha Trang) would ensure sustainability of the gains so far achieved in this Project.

## **5.2 Lessons Learnt**

Critical to the success of the present project was its strong endorsement by UoF's Rector, Professor Dr Quach Dinh Lien, and the commitment of the university to ensure staff and infrastructure resources were unstintingly made available to the project. Without such commitment and support from the University, the Project most likely would have failed. The cultural differences that exist between Australian and Vietnamese people had to be recognized otherwise the Project also would have foundered. Vietnamese people have a strong community culture and a well-defined hierarchical system of influence and procedure. This culture tends to inhibit the willingness of subordinates to openly question or make value judgements about the work in the presence of their administrative superiors or even their peers. This can be frustrating when trying to get young and junior Vietnamese scientists to express their ideas or to challenge those of others. These cultural sensitivities had to be acknowledged and accepted when planning how the work, especially training activities, could best be carried out. A further issue was the one of language. Vietnamese is a very tonal language, and distinguishing tones is very difficult for an English speaking person. Conversely, English is poorly understood by most Vietnamese. Thus, ensuring that key people in the Project team had fluency in English was a critical success factor.